HOUSECRAFT SCIENCE

J. M. HOLT

129

HOUSECRAFT SCIENCE

OTHER BOOKS BY
MISS J. M. HOLT

COOKERY AND NUTRITION

PROGRESSIVE NEEDLEWORK

FABRICS AND CLOTHING

(G. Bell & Sons Ltd)

THE ART AND PRACTICE OF MENDING

(Sir Isaac Pitman & Sons Ltd)

HOUSECRAFT SCIENCE

by

J. M. HOLT

First Class Diplomée in Domestic Subjects: Formerly Domestic Science Mistress, Fairfield High School for Girls, Manchester

LONDON

G. BELL & SONS LTD

1964

First published 1953
Reprinted 1953, 1954
Second Edition, 1956
Reprinted 1958, 1960, 1962, 1964

Printed in Great Britain by
The Camelot Press Ltd., London and Southampton

Preface

'HOUSECRAFT SCIENCE' endeavours to deal in a simple and practical manner with each aspect of the house and the home from the choice of site and building construction to kitchen planning, care of rooms and the use of modern domestic appliances.

The book is intended to give as complete a picture as possible of the many issues involved in successful house management, with the scientific background on which they are based. It is hoped that it may appeal to those who are expecting to set up homes of their own with all the conditions for health and comfort that science can devise, and to those who are interested in problems of housing and home making.

J. M. H.

MANCHESTER
1953

Contents

I

The House

The basis of the family is the home, and the happiness of home life depends not only on material well-being, and the comforts and amenities brought to us by modern science, but on deeper personal and spiritual factors.

It is necessary to distinguish between the house and the home, and to realise that home-making is not only a science, but an art. The science of housecraft can, however, be of the greatest assistance to the home-maker, particularly in so far as it assists and improves the health of the family, since ill health is one of the greatest causes of unhappiness and poverty.

A good modern house, whether it be large or small, should be so constructed and fitted with efficient equipment that a sufficiency of fresh air, pure water, good sanitation, sunshine and warmth, and labour-saving devices are availabie.

It is realised that a large proportion of the population has, perforce, to live in houses which were built in an age when the principles of modern hygiene were unknown, and which have deteriorated since they were built. To them, and to those who have little or no choice as to situation, the following features of the perfect house can be held out only as an ideal for the future.

It is most essential to health that sufficient light and air and sunshine should be available in all living-rooms. In this respect the home-maker has to rely on the judgement of the architect and builder, but modern town-planning attempts to avoid houses grouped in straight, monotonous rows with windows facing back and front, all in the same direction, whatever the outlook. For instance, the living-rooms can be made

to face, as far as possible, south or south-west, so that a greater share of sunshine and more warmth may be obtained. If windows can be arranged on more than one wall to give a south aspect from one window and a west aspect from another a lighter and more pleasant room will result. Kitchens and workrooms should, if possible, be provided with a north and west aspect, and larders for coolness should face north; lavatories, bathrooms and cloakrooms may have the less favourable east aspect.

The windows should be sufficiently large to admit a reasonable amount of light and air, though overmuch glass in a cold climate or situation may chill the rooms. Sun parlours and glass-enclosed verandas are useful in obtaining the benefits of sunshine, especially as the newest types of glass are so made that they do not obstruct the passage of the health-giving but invisible ultra-violet rays of the sun.

Situation

It is impossible to obtain light and air if houses and windows are overshadowed by adjacent buildings, by trees or by other obstacles. For this reason, no building should throw its shadow on neighbouring buildings and, in cities in particular, the property owner guards very strictly his right of light when building operations chance to threaten it. There are usually bye-laws which stipulate how many new houses may be built to the acre, eight or ten being usual. This ensures that houses are not unduly crowded, that the danger of overshadowing is avoided, and that space is available for gardens.

Large trees grown close to houses throw shadows, restrict the passage of air and increase the humidity; the roots are also dangerous to foundations. Although trees offer a good screen from wind, they should be planted some distance from the house, on the side of the prevailing wind, while low-growing ornamental or fruit trees may be nearer to the house.

A house built too closely against a hillside, or at the bottom of a steep hill, will also suffer from disadvantages, such as lack

of sunshine, difficulties of drainage, and even flooding in the case of those at the lowest level. Continuously smoky chimneys may also be due to such a situation.

Other points which should be borne in mind are the nearness of ponds, canals and rivers, which may give rise to dampness; and of factory chimneys, offensive trades and noise and dirt from railways, etc., though some of these may well prove unavoidable in many districts.

Soil and Subsoil. The dryness and warmth of the house depend to a great extent on the soil on which it is built. Beneath the ground, a large amount of water may be retained, according in the main to whether the subsoil stratas are composed of permeable or impermeable material. Some soils, such as clay and marl, hold the water and will not permit it to penetrate further; if they are near the surface, the level of water beneath the surface will be high. Other soils, including sand and gravel, and some rocks, such as chalk, sandstone and limestone, are permeable and allow water to pass through readily, the interspaces being filled with air. Other rocks, such as granite, are impermeable, but the water runs off their surface readily, leaving the site dry.

Where sand or gravel lies upon a bed of clay, the water level will be extremely variable, and houses built above will suffer from the disadvantages of a damp site. In wet weather, the clay will collect and hold the water, which will rise into the sand above, driving out the air into the basement (if there is one) of the house. Since ground air contains more carbon dioxide than atmospheric air, this may prove unhealthy. The carbon dioxide content is increased where there are organic substances in the surrounding soil.

Houses may be built on 'made ground', which implies that inequalities in the site have been filled in by dumping refuse such as cinders, tins, etc., on the site. It is then left to settle before building takes place. This type of soil may, however, settle still further after the house is erected, and then it will

cause cracks and subsidence in the fabric and in drains and sewers.

It is not always possible in built-up areas to ascertain what the nature of the soil and subsoil may be but, where there is a choice, a house should preferably be built on a rocky subsoil or on a well-drained site.

Water-logged soil can be greatly improved by a proper system of drainage, which entails laying beneath the soil loosely connected sections of small, unglazed earthenware pipes which collect the water, being themselves porous, and carry it to ponds, streams or pits filled with cinders. On properly planned large-scale building sites, if they are damp, draining of the soil will precede building operations.

Building Construction.

The first step in building is the preparation of the foundations to make a solid and stable base for the walls of the house. The ground is dug out beneath the position to be occupied by the walls to about 1 ft. 6 in. below the ground level under normal conditions and concrete foundations are then filled in, their width and thickness depending on the nature of the soil and the height and width of the walls they are to support. (See Fig. 1).

The site between the walls is then cleared of the top soil to about 6 in. deep, and the ground so removed is replaced with 6 in. of concrete. Concrete being permeable neither by water nor gas, this lay of concrete is most important to the dryness and healthiness of the house. A space is then left between the concrete and the floor boards above, which is ventilated by air bricks (bricks perforated with holes) to prevent the wood from rotting and the growth of the destructive dry-rot fungus in the enclosed space. The presence of air also helps to maintain the temperature of the house, since air is a bad conductor of heat or cold. Care should be taken to see that the airbricks do not become blocked up in due course on the outside owing to soil being heaped against them or to other causes.

Building materials. Ideally houses are constructed of materials most readily procurable in the locality, since transport adds considerably to building costs. Local stone is found to weather better than that imported from other districts and, in Scotland and districts in the Pennines, granite or limestone is much used to build the grey stone houses typical of those places. In Cornwall and in the Cotswolds local stone is almost exclusively used in the country districts. Houses of stone have thicker walls than those built with other materials and are consequently drier, warmer and more durable.

Concrete is now sometimes used for houses where speed in building is necessary. The building of all-wooden houses is not encouraged owing to their inflammability, but in some types of the prefabricated house, the wooden frame-work is covered with non-flammable asbestos, and the bye-laws have thus far been relaxed.

Bricks are the building material most commonly used, but they differ considerably in colour, texture and durability. They are, however, usually porous and are capable of absorbing a large amount of water. This is due to capillary attraction, the water rising in the fine spaces in the bricks, as it would in a fine tube inserted in water, the dampness thus passing upward from brick to brick in the wall of the house.

Damp-proof Courses. In view of this capillary attraction, it is necessary to construct a damp-proof course in the walls of houses above which water from the surrounding soil, or from the lower bricks, cannot rise. The walls are built up from the foundations to a level of at least two bricks above the earth, and a course of impermeable material is placed as a continuous complete layer round the whole structure. This layer must be below the woodwork of the flooring within the house and is frequently made of asphalt or bitumen, but blue brick, slate or lead sheeting are more durable though also more expensive. The laying of a damp course is essential in modern building, and if it is omitted a builder may be prosecuted.

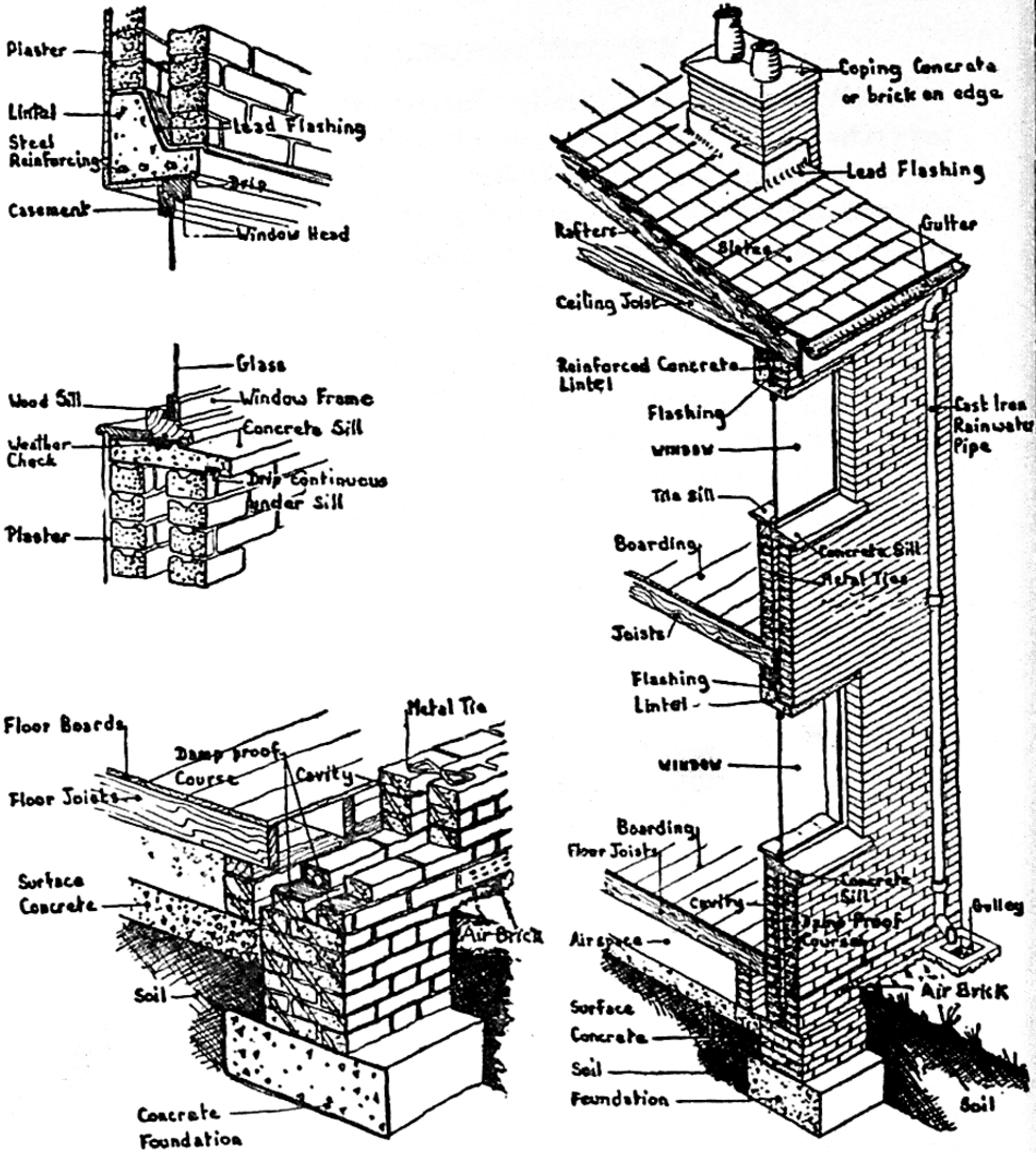


Fig. 1. Building Construction. *Top left and centre left:* Structure of wall above and below a window. Note the lead flashing and the 'drips' to prevent rain water creeping inwards. *Bottom left:* Structure of wall with damp-proof course cavity wall, and air brick. The method of supporting the floor is also shown. *Right:* Complete structure of house from foundation to roof. Note the lead flashing round the chimney.

Mortar. The joints between bricks and stones are filled with mortar made from a mixture of one part of cement to three parts of clean sand, free from salt. These are mixed together with water, and set into a rock-like substance which binds the bricks together. Correct proportions, clean materials and proper mixing are necessary in order to produce a good mortar without which walls soon will get into a poor condition and require repointing; such walls readily absorb moisture.

Construction of Walls. The structure of the wall and the method of laying the bricks is spoken of as bonding and may vary according to the district; usually, a well constructed wall has the bricks laid lengthwise and cross-wise alternately, and should have a thickness of at least nine inches, though a greater thickness is to be preferred. Still further to ensure the dryness and warmth of houses, a *cavity wall* is usually built, which is a double wall with a space or cavity of two to three inches, containing air, between the two walls. The walls are tied together at intervals with galvanised iron stays, to make one fabric of the whole. One of the commonest causes of damp walls is mortar left on these stays by careless workmen. The air space acts as a bad conductor of heat, so that the warmth of the house is retained, while dampness cannot be transmitted to the bricks of the inner wall across the intervening space.

The outer surfaces of the house wall can be made damp and wind proof in exposed positions by a covering of cement and sand, called 'rendering' and, with pebbles embedded in it, 'rough cast'; in exposed positions, for instance near the coast, the walls are given an over-lapping layer of slates or tiles.

Interior walls and ceilings are plastered and finished by painting, distempering or by papering; painting and distempering are perhaps the more hygienic methods, as dust and even vermin may lodge behind an ill-fitting paper, but paper is slightly warmer and lends itself to greater decorative effects.

Woodwork. Much woodwork is used in the structure of a house for joists, beams, flooring, etc., and it is essential that

such wood is of the right type and well seasoned. Spruce and oak are considered best. Any wood that has not been seasoned will shrink and crack or be subject to dry rot. Ill-fitting windows and doors, open cracks in floors and skirtings, are the results of the use of such wood and are the cause of much discomfort in the home. Wood is preserved by painting and varnishing and, in some positions, by the application of creosote.

The Roof. Tiles or slates are required on sloping roofs of houses, the sloping roof being used in countries where there is much rain or snow. In warm climates, and with the modern concrete house, flat roofs are built, and these are now usually covered with asphalt.

Tiles and slates are non-porous; they are nailed to roof battens (upon which sheets of roofing felt have first been spread for additional warmth and dryness) and if they become broken or damaged or there is insufficient lap, rain will penetrate. It is not unusual for water to find its way through roof junctions or round chimney shafts owing to faulty lead flashings, leading to damp ceilings and walls. Flashings consist of strips of lead sheet embedded in the mortar of the pointing along one edge to cover joints between brickwork and the tiles or slates of the roof. Another cause of dampness may be neglected or ill-constructed gutters. Windows should be provided with ledges with a 'drip ledge' beneath them to prevent dampness creeping back into the brickwork. Damp interior walls, especially if covered with mildew or a fungoid growth, are most unhealthy, and the cause should be investigated and the trouble cured at once.

It will be seen that the building of a house entails much specialised knowledge and skill, and that on the good workmanship of all concerned the health and comfort of the household will depend.

2

Water

WATER is needed for innumerable purposes besides drinking—for example, washing and cleaning, sanitation, swimming baths and wash-houses, industrial and manufacturing processes.

In cities, the amount of water required for household use per head of the population is very large and is increasing continually: 35–40 gallons daily is an average allowance; in country districts the amount used is smaller.

Water is a compound of oxygen and hydrogen in the proportion of one volume of oxygen to two volumes of hydrogen. Water to which a little acid has been added, can be split up into parts by passing an electric current through it; this process is known as electrolysis.

Water collected naturally from rainfall also contains a certain amount of air and other dissolved gases. Water which is collected after passage through or over soil containing organic material dissolves carbon dioxide, and becomes slightly acid, which adds to its solvent properties. Water can be purified by distilling—that is by boiling, when the water is driven off as a vapour; the vapour is then cooled and condensed to liquid form again. In this state, it contains no air or other gas and no dissolved substances. Distilled water is, therefore, quite pure, but such water is most insipid and, except for scientific purposes, such a standard of purity is not necessary or desirable.

Water has remarkable solvent properties, and many substances, both organic and inorganic, can be dissolved by it. Any such substance, whether harmful or not, is regarded as an

impurity in comparison with the lack of such matter in distilled water. Impurities can be divided into dissolved impurities and suspended impurities.

The natural flow of water over the ground and through rocks tends to add a large amount of mineral substances to its composition. The chief mineral salts are bicarbonates and sulphates, and chlorides of the metals calcium, magnesium and, to a less extent, iron; sea water contains sodium chloride. These metallic salts are dissolved most readily in a slightly acid medium and, since carbonic acid gas or carbon dioxide is present, the mineral salts are readily dissolved and water therefore contains varying amounts of mineral salts, according to the type of ground through which it passes; on this content depends the degree of 'hardness' of the water. A certain amount of dissolved mineral salts improves water for drinking, but hard water is not good for washing and cooking purposes.

Distilled water and rainwater which has been collected immediately are both soft waters and when soap is added they make a lather which remains on the water and which removes dirt and grease efficiently. Hard water which contains dissolved bicarbonates, sulphates and chlorides of calcium and magnesium does not make a lather readily. When soap is added, a grey and greasy scum is formed instead, which is deposited on the sides of the vessel or any substances in the water, such as clothing; dirt and grease are not removed. This is accounted for by the fact that a chemical reaction takes place between the soap and the dissolved salts, forming an insoluble scum. Therefore, no lather can be produced until all the calcium or magnesium compounds have been precipitated. A standardised soap solution of known strength is used as a test for hard water; the amount of solution used before a lather can be produced and sustained for a certain length of time is accurately measured and the amount of hardness determined.

Two Types of Hard Water

(*a*) *Temporarily Hard.* Temporarily hard water can be softened by boiling; permanently hard water cannot. Temporarily hard water is water containing carbon dioxide which, in its passage through the ground, has dissolved calcium or magnesium carbonates to form the bicarbonates; permanently hard water has dissolved sulphates or chlorides of calcium and magnesium.

It has been said that carbonic acid gas is present in the ground and that it will render water more solvent of mineral salts. When water contains dissolved carbon dioxide and comes into contact with insoluble calcium carbonate, the calcium unites with carbonic acid and forms a bicarbonate which is soluble in water and a clear, hard water results. As long as the gas is present, the calcium bicarbonate is held in solution, but when the water is boiled the dissolved gas is driven off and leaves the water as bubbles. The calcium or magnesium bicarbonate is then decomposed and the insoluble carbonate is thrown out of solution and is deposited on the bottom and sides of the vessel in which the water has been boiled as a sediment or fur. This deposit has many objectional effects: (*a*) It collects on the sides and base and fuel is wasted in boiling kettles which contain fur. (*b*) It will gradually close hot water pipes leading from boilers, thus slowing circulation, and by deposition within the boiler will hinder its heating. The pipes can eventually become entirely blocked, and since, if water boils in an enclosed space the steam will have no room for expansion, an explosion will result. (*c*) The sediment will be deposited on the sides of wash boilers, and will cling to clothes as grey specks.

Boiling, as a method of softening temporarily hard water is, therefore, efficient as far as the softening process is concerned, but it is expensive and has many objections. Moreover, it can only be performed on a small scale. On a large

scale, temporary hardness can be removed by adding quicklime to the water, and this service is performed by the water companies in districts where water is above a certain standard of hardness. This process is known as Clark's process. The lime combines with the carbon dioxide from the bicarbonate to form calcium carbonate, and this insoluble substance forms a milkiness in the water and then settles—the water above being soft. Since the amount of lime added must be exactly calculated, the method can only be employed in a scientific manner. It may be shown as: Calcium bicarbonate+slaked lime=Calcium carbonate+water. Moreover, local authorities do not supply water from which every trace of hardness has been removed, because soft water will slowly dissolve lead pipes, which may result in lead poisoning for the consumer.

(*b*) *Permanently Hard.* Permanently hard water contains the soluble salts of calcium and magnesium dissolved from the rocks. Permanently hard water cannot be softened by boiling. When, however, washing soda (sodium carbonate) is added, the calcium compound is converted into a soluble sodium compound which does not cause hardening of water and does not affect the lathering properties of soap.

The amount of sodium carbonate needed to soften a sample of permanently hard water can be accurately gauged in the laboratory, but for ordinary domestic purposes a slight excess of sodium carbonate is not harmful. In the washing of woollens, however, and other delicate fabrics, it is wise to substitute borax or ammonia, these two alkalis having the same water-softening effect. It is possible, moreover, to soften water by soap solution alone, but this is an expensive and wasteful method. When using both soda and soap, the soda should be added first to soften the water before the soap comes into contact with it. Water-softeners can be purchased for use in hard water districts, which may be connected to the water supply pipe, and are a great saving of time and money.

Pure and Impure Water

Suspended Impurities. Finely divided particles of organic and inorganic matter are gathered by water (*a*) as it passes through the air, where fine dust and pollen, carbon, etc., may be present, (*b*) from the surfaces on which it falls, e.g. dust, animal droppings, bacteria, etc., and (*c*) from the ground through which it passes, e.g. decaying animal and vegetable substances. Polluted water from drains may come into contact with water flowing through the ground, adding still further to the impurities which remain in suspension when the water is collected for use. Apart from the effect on the flavour and appearance of water, the presence of suspended impurities, particularly of an organic nature, is an infallible sign of the presence of living organisms. These may not necessarily be the germs of disease, but, since the organisms are invisible, there is no means of distinguishing between the harmful and the harmless, except in the laboratory by the help of the microscope. The germs of typhoid fever, cholera, dysentry, diphtheria are water-borne, and water polluted by organic substances, particularly from sewage, will give rise to epidemic diseases.

Characteristics of Pure Water. Pure drinking water should be clear and leave no sediment; it should be odourless and flavourless, but not insipid, and a certain amount of dissolved gases and mineral salts will improve its quality. These properties are no guarantee that the water actually is pure, for a large amount of carbon dioxide in the water, giving it a sparkling and clear appearance, may be accounted for by the fact that there are decaying substances in the soil, and such water may be highly dangerous. However, water that has not the properties mentioned will be immediately suspected.

The purity of water depends to a great extent on the manner in which it is collected. The sources of water are (see Fig. 2):

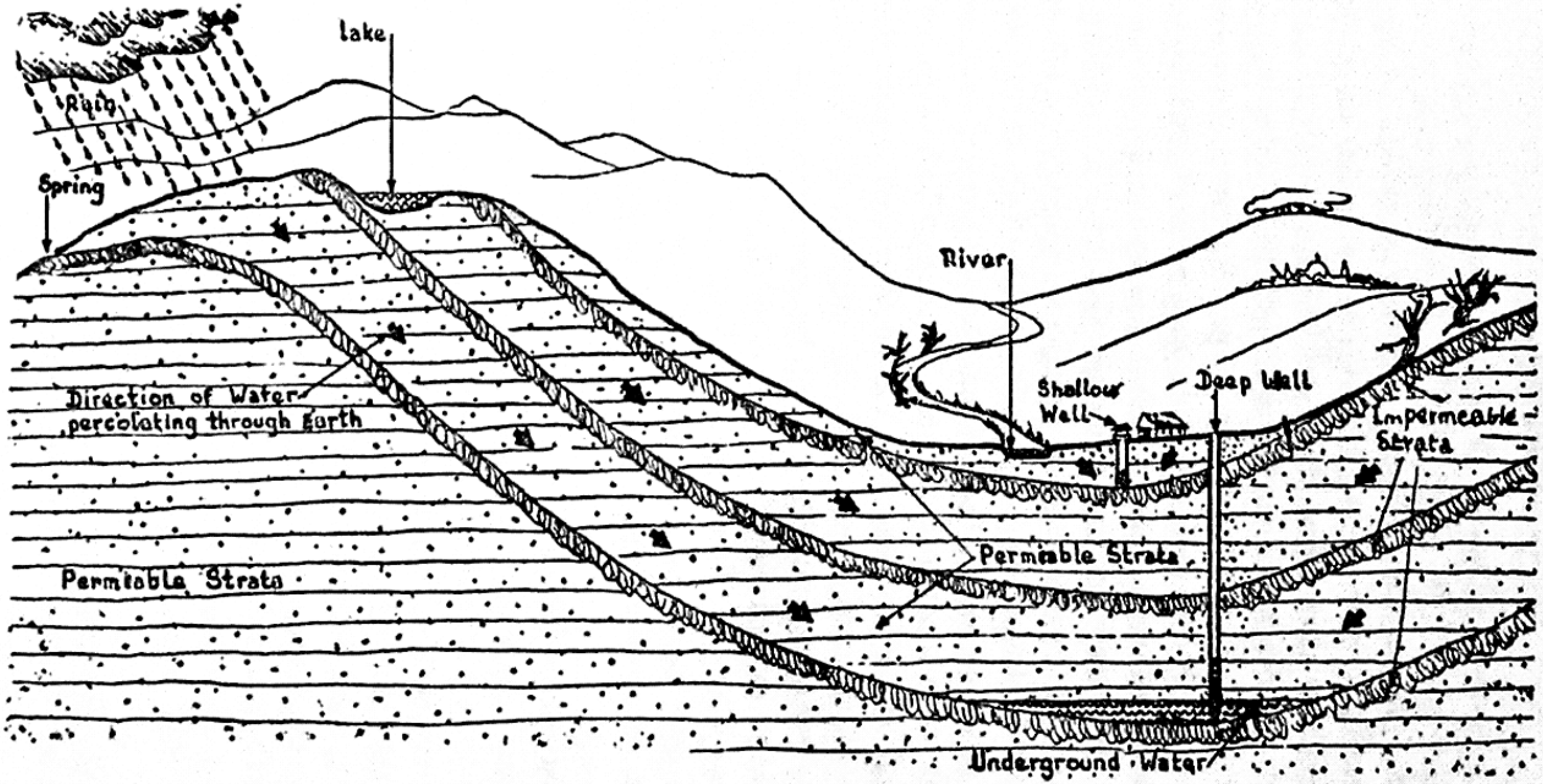


Fig. 2. Sources of Surface and Underground Water. This shows clearly how water is collected by impermeable strata, how wells reach this water and how and where springs occur.

(1) *Surface water.* Rainwater is pure if collected and stored in a clean receptacle. It is, however, insipid and is intermittent as a supply.

Upland surface water is collected from the sides of mountains and hills, and gathered into tarns and lakes, natural or artificial, which are used as reservoirs. The majority of large towns which are within sixty miles or so of hills or mountains or thinly populated country obtain their water in this way. Such water is pure, soft, palatable and abundant.

Lowland surface water. Water flowing through cultivated ground and past dwellings is not suitable for drinking purposes unless it is efficiently purified. It will contain organic substances, probably sewage, and its use is extremely dangerous.

(2) *Underground water.* Water which percolates through the ground and collects on the impermeable strata of the sub-soil, where it can be tapped and brought to the surface:

Springs. These may occur on the sides or at the base of mountains or hills, where the land surface cuts across a permeable layer of rock overlying an impervious strata. The water emerges along the junction. Spring water sometimes comes from great depths and great distances and is, therefore, well filtered and pure. It is hard, cold, palatable, and its quantity will remain constant. Such water is known as deep-spring water.

Shallow wells are made by boring the ground until the first impermeable strata is struck. Water will trickle from the surrounding soil into the bore. As this soil is usually cultivated, there is always the possibility of organic substances and disease germs polluting the water. Shallow wells near farmsteads and villages may drain cesspools, ponds, etc., and yet the water may appear clear and palatable.

Artesian or *Deep wells.* Such wells are bored to tap deep underground sources of water. Deep-well water is pure, hard if it flows through limestone or chalk, and a large volume of water

may be collected by this means, sufficient to serve a fair-sized community.

Purification of Water

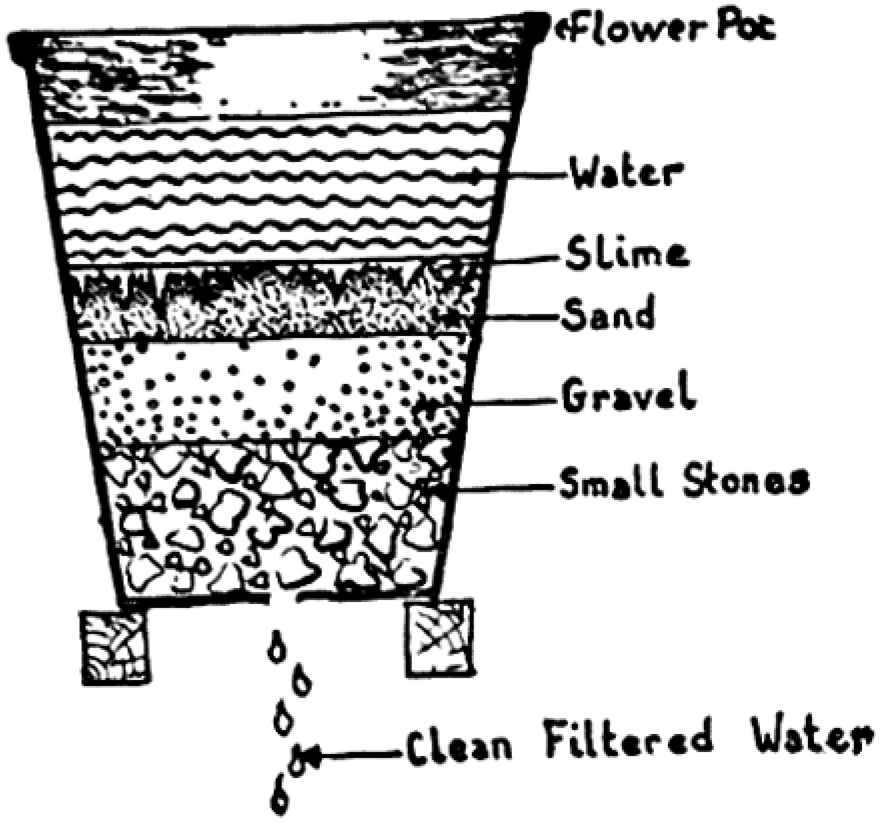
(*a*) *Boiling.* Even polluted water can be made safe by boiling for ten minutes. The spores of some germs are resistant to a certain amount of heat, but after this time they too will be destroyed

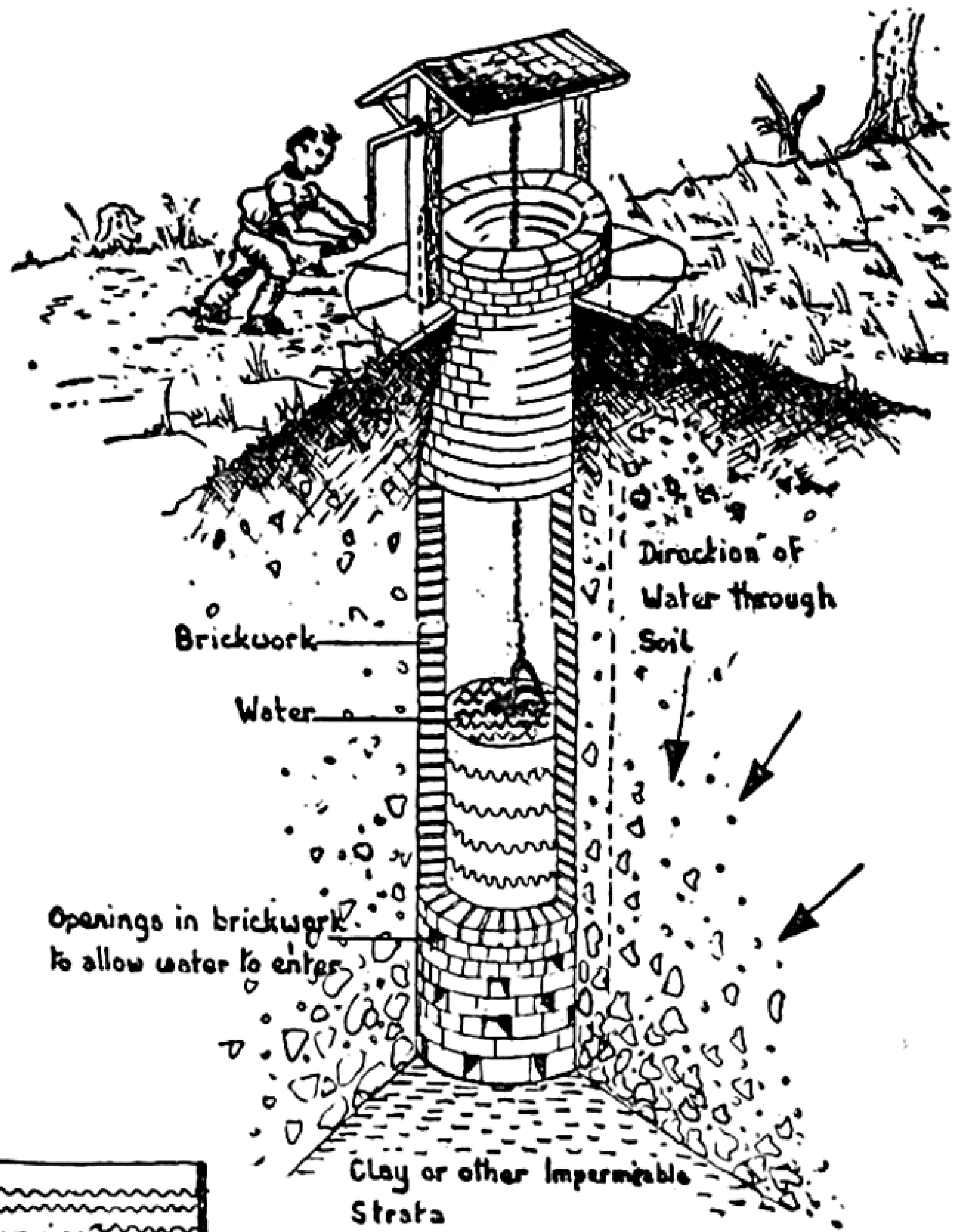
(*b*) *Storage.* If water is collected in large quantities and stored in a reservoir for fourteen days, exposed to the sunshine and the process of oxidation, the suspended impurities will sink to the bottom and harmful organisms will be destroyed by the action of the sunshine and the processes of oxidation; animal and vegetable life present in the water will also assist in the purification as they feed on the smaller organisms. This method is usually used in conjunction with filtration.

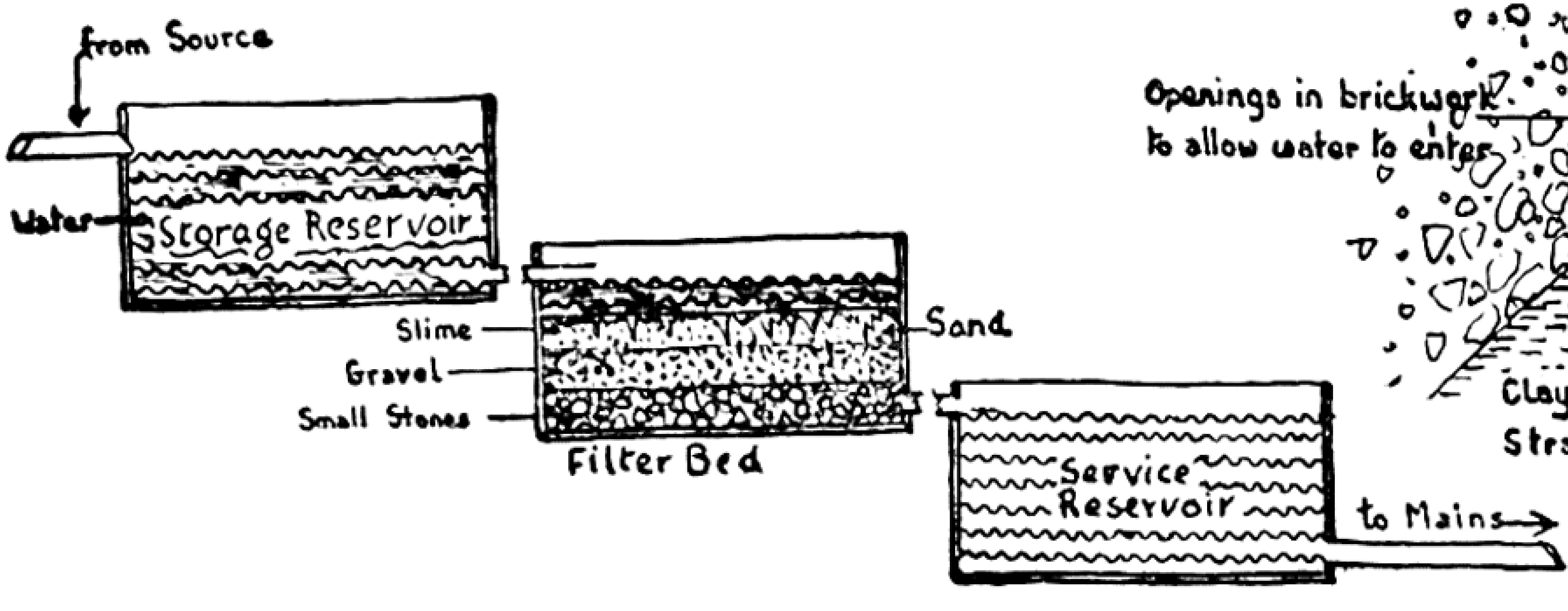
(*c*) *Filtration.* The suspended impurities will be removed if water is allowed to pass slowly through a porous substance, such as unglazed porcelain or charcoal, or between the interstices of sand and gravel as shown in the poor man's filter (opposite). In large-scale filtration, water passes from reservoirs to filter beds at a slightly lower level. Filter beds are composed of a 2–3 ft. layer of fine, clean sand, next a 3-ft. layer of gravel and, finally, a layer of small stones; the water is passed from the bottom of the filter beds to a further supply reservoir for distribution. The filtration is partly mechanical, i.e. the impurities will cling to the sharp particles of sand and gravel, and partly biological or bacterial in action. The surface of the sand gradually becomes covered with a layer of slime. In the slime are bacterial organisms and microscopic plants, which will destroy other bacteria in the

* * *

Fig. 3. Simple Well and Water Purification. *Top left:* The 'poor man's filter'. *Bottom:* Large scale filter and storage system. *Right:* A surface well and how it collects water.


Flower Pot
Water
Slime
Sand
Gravel
Small Stones
Clean Filtered Water


Direction of Water through Soil
Brickwork
Water
Openings in brickwork to allow water to enter
Clay or other Impermeable Strata


from Source
Water
Storage Reservoir
Slime
Gravel
Small Stones
Sand
Filter Bed
Service Reservoir
to Mains

water. Gradually, the slime accumulates to an increasing depth in the sand and must be removed. The filter beds are then emptied and cleaned, but a certain amount of slime is still left upon the sand, because of its cleansing effect. Many authorities use a primary or pressure filter to remove the larger impurities more rapidly, as a first stage.

Mechanical filters on a small scale are procurable for fixing on main water taps. They are formed of an interior tube of unglazed porcelain open at the bottom, fitted into a somewhat wider cylinder, closed at the bottom round the inner tube. The water, under pressure, passes into the outer space and can only escape through the porous porcelain of the inner tube, where it trickles out at the bottom. Such filters require cleaning at intervals.

(*d*) *Chemical Purification* is obtained by the addition of suitable disinfectant substances which will destroy bacteria without being harmful to the consumer. The most used is chlorine, which is issued in tablet form to soldiers in the field to purify possibly contaminated drinking water. The amount of chlorine must be carefully estimated, and the slight flavour resulting is a disadvantage of this method of purification. Chlorine in small quantities is used by most local authorities as an additional safeguard, and it is largely used for purification of water in swimming baths.

(*e*) *Distillation.* Water may also be purified by distillation, but the expense of heating the water and the apparatus required put it outside the bounds of practical use on a large scale. It is used, however, on ships to provide fresh water from sea water.

3

Removal of Waste Substances

THE removal of waste substances quickly and efficiently from our dwellings is one of the necessities of civilised life, especially as it is lived in large cities.

The local authorities are responsible to the community for providing means for the disposal of waste by their sanitary services and sewage systems. Ultimately, however, this important matter is in the hands of the citizen, and a knowledge of the structure and functions of each piece of sanitary equipment to be found in the home, and its connection with those of all the neighbours, should be part of our education. Meticulous cleanliness in the care and use of water-closets, in particular, at home and school should be observed by everyone.

Waste substances from a house are of two types—namely, solid and liquid.

Solid Substances

These are (*a*) inorganic matter, e.g. cinders, metals, ashes, (*b*) organic matter, e.g. peelings, waste food, tea-leaves, scraps of paper and cloth, (*c*) tins and containers which, though made of metal, may contain scraps of food and other waste materials.

Nearly all solid substances can be made use of industrially or as feeding-stuffs for animals, and special containers are issued for collecting for the latter purpose by many local authorities. It requires some care and discrimination to separate papers, cloth, metals and foodstuffs from one another, and keep them for salvage collection, but the public responded well to appeals made to them during the war. Such separation presupposes an

efficient collection service; where this is not forthcoming, the householder obviously cannot turn all this material to account. Where this efficient collection can be achieved, paper, cardboard and rags can be used for papermaking, bones can be used for glue and size, metals for augmenting the supply of scrap for steelworks, etc., and waste food for pigs and other animals. Dustbins are necessary for town-dwellers; they are emptied once a week, and in these are placed ashes, broken crockery and tins. Even where there is no means of collecting food, it should never be placed in the dustbin, as it encourages flies and vermin, and, when it decomposes, makes the bin foul and gives rise to bad smells. If it cannot be fed to animals, waste food should be buried in the ground or burnt. Dustbins should be kept dry and covered; dampness leads to decomposition and makes the ashes stick to the bin. The practice of emptying the teapot into the bin leads to dirty dustbins. If dustbins are used for dry refuse only, they will not require any disinfecting, but if they have been misused they may be brushed out and a dry disinfecting powder sprinkled in. The contents of the bins are collected by the local authority and emptied into refuse carts, which are normally covered to prevent dirt and dust being disseminated. The refuse is then taken to the local incinerator and burnt, the ashes making a fine powder which, when mixed with cement, can be used for making paving-stones. The heat of the incinerator is made use of in the disinfecting station, which is usually placed on the same site by most local authorities for stoving infected bedding and clothing.

In some urban areas solid refuse is tipped on to disused land to fill up inequalities. Such land cannot be used for building purposes till several years have elapsed, when the ground will have settled and become quite firm.

Liquid Refuse

There are three types of waste water from the ordinary household: (*a*) storm water, (*b*) the water used for washing and

cleaning purposes from sinks, baths, etc., and (*c*) water containing excreta from water closets.

(*a*) *Storm Water.* Storm water falling on roofs is collected in gutters and conveyed down the side of the house in pipes to discharge over an open grid. Where the guttering is inadequate or faulty, the water will run down the walls of the house and cause dampness, especially in upper rooms. Sometimes also the gutters become choked with leaves and do not convey the water away efficiently. Storm water is clean as a rule. In heavy thunderstorms, the amount of water may be too great in volume for the capacity of the drains and floods may be caused. Houses situated at the bottom of a hill where there is a junction of several sewers may suffer from this disadvantage.

The open grid leading to the drain into which storm water flows, as well as the water from sinks and baths, is known as a gulley trap. It is connected with the main drain and is made of glazed earthenware, as are the other house drainpipes. The trap consists of a shaped bend at the bottom of the grid, 2 ft. from the top, so that the water running down is collected in the bend or trap and a seal is made between the sewer and the top of the grid (see Fig. 4). This water seal is a characteristic of all well-planned sanitary equipment, and has the purpose of shutting off the main sewer from the household premises, thus avoiding the passage of sewer gas, which is both harmful and unpleasant. The gas is produced by the decomposition of organic substances in the sewers and is particularly liable to collect if the fall and pressure of water in the pipes is insufficient to force the contents along quickly. The safeguards against the gas are: (*a*) effective trapping; (*b*) adequate ventilation: the water which discharges over an open grid permits of fresh air entering the pipe; (*c*) a rapid flow and quick removal of all waste water from the premises.

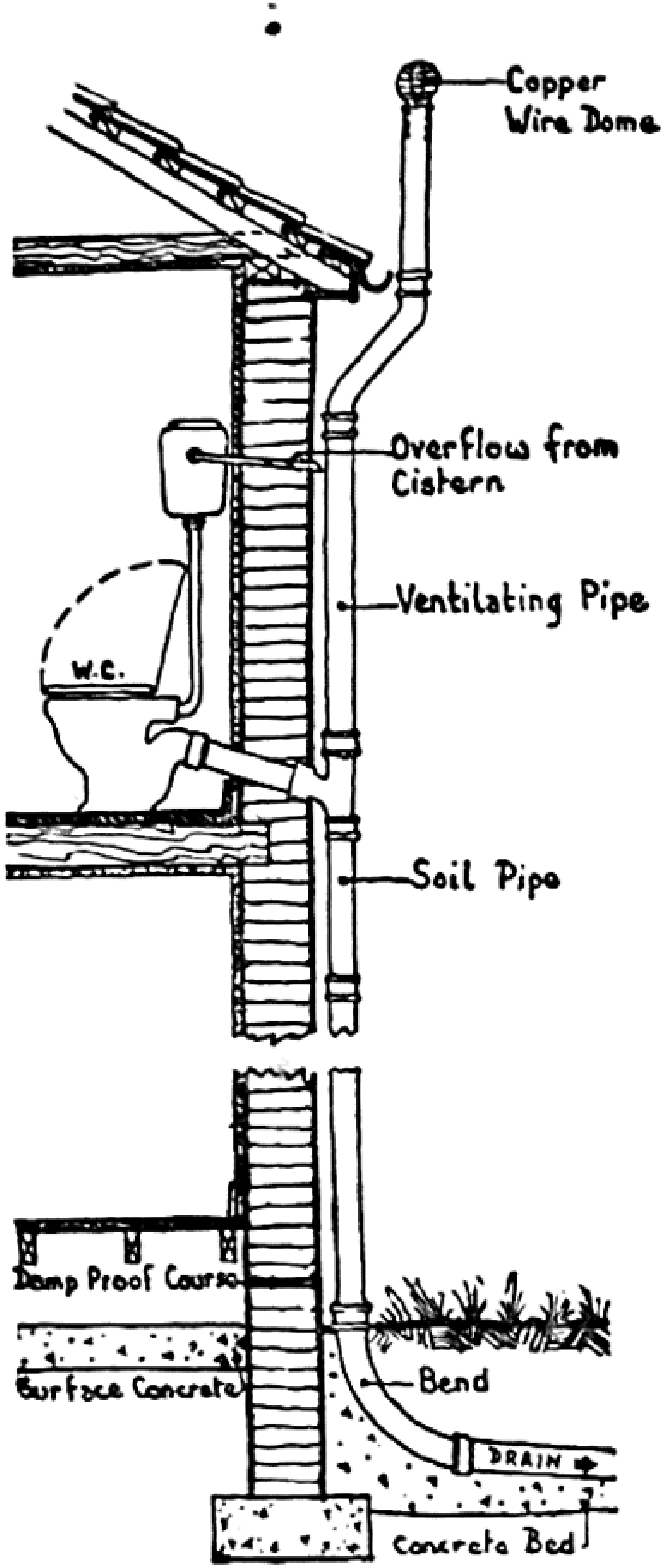
(*b*) *Waste Water from Sinks, Baths, etc.* This water will contain soap, soluble dirt, grease and traces of food, tea leaves,

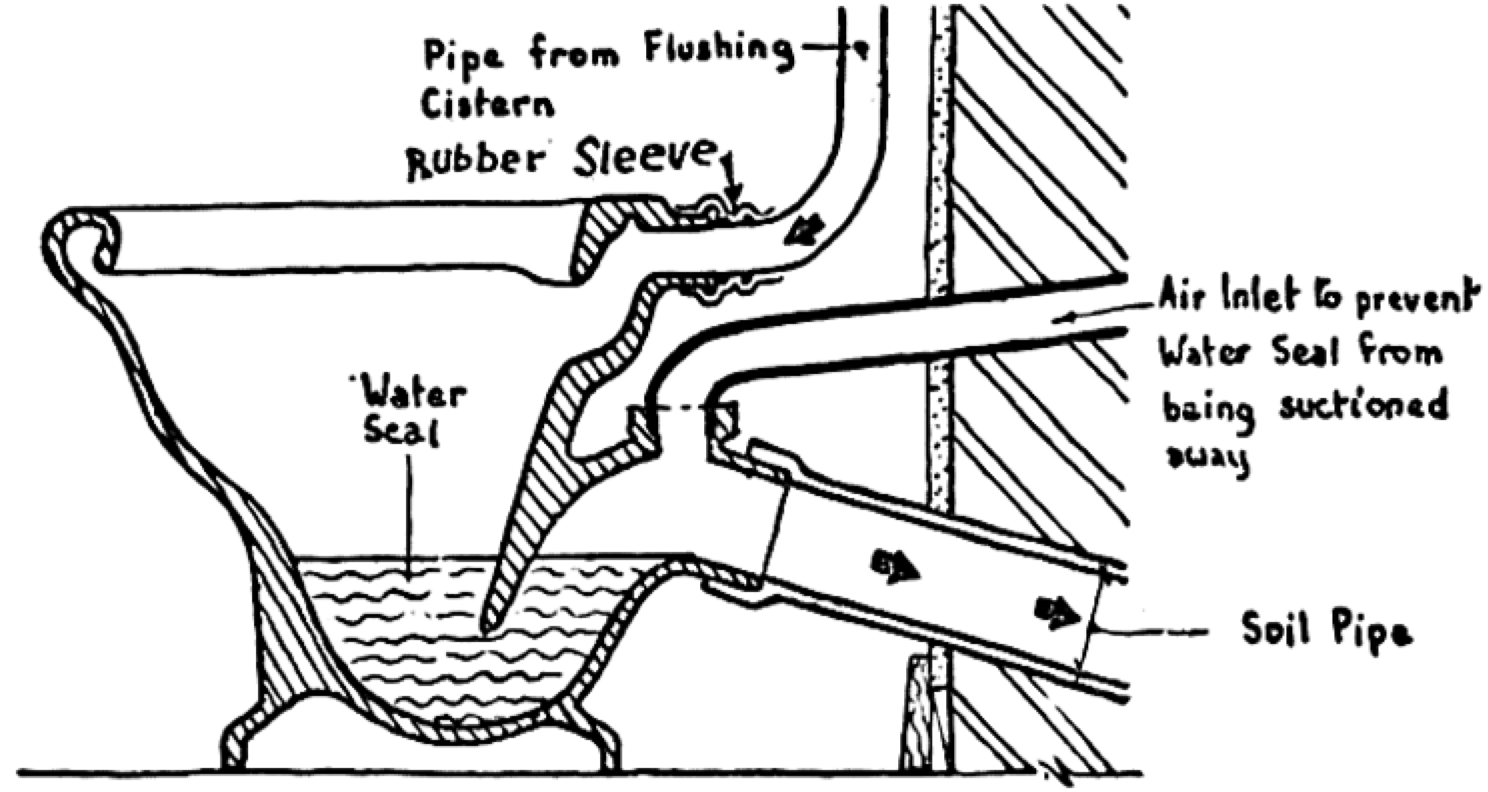
etc. The water passes through a mesh at the sink outlet, and into a lead pipe $1\frac{1}{2}$ in. in diameter. At a distance of approximately 10 in. from the outlet, the water passes through a syphon S bend or trap, which acts as a further means of disconnecting the house from the sewer. Eventually the pipe leads to a gulley trap (see Fig. 4). As the diameter of the lead pipe is small, it is essential that no hard or solid substances are allowed to clog the pipe and prevent the free escape of the water. Such substances as sand or soil washed from vegetables, peelings, peas or lentils, pieces of string or worn dishcloth will all collect in the waste pipe and caked grease or fat will bind them together. In the event of the waste pipe becoming clogged, it is essential that nothing hard be poked down the pipe, as the lead piping is easily broken. A handful of washing soda placed on the grid and a kettlefull of boiling water will sometimes dissolve grease; a plunger worked vigorously from the top will force down tea leaves and food and, if all else fails a spanner can be used to remove the screw plug at the bottom of the S bend, and so any hard or solid object can be extracted. Regular cleaning with hot soda water and the occasional use of a disinfectant is all that is required. It should be remembered that clean water poured down the sink after cleaning or washing up will ensure that clean water is left in the trap.

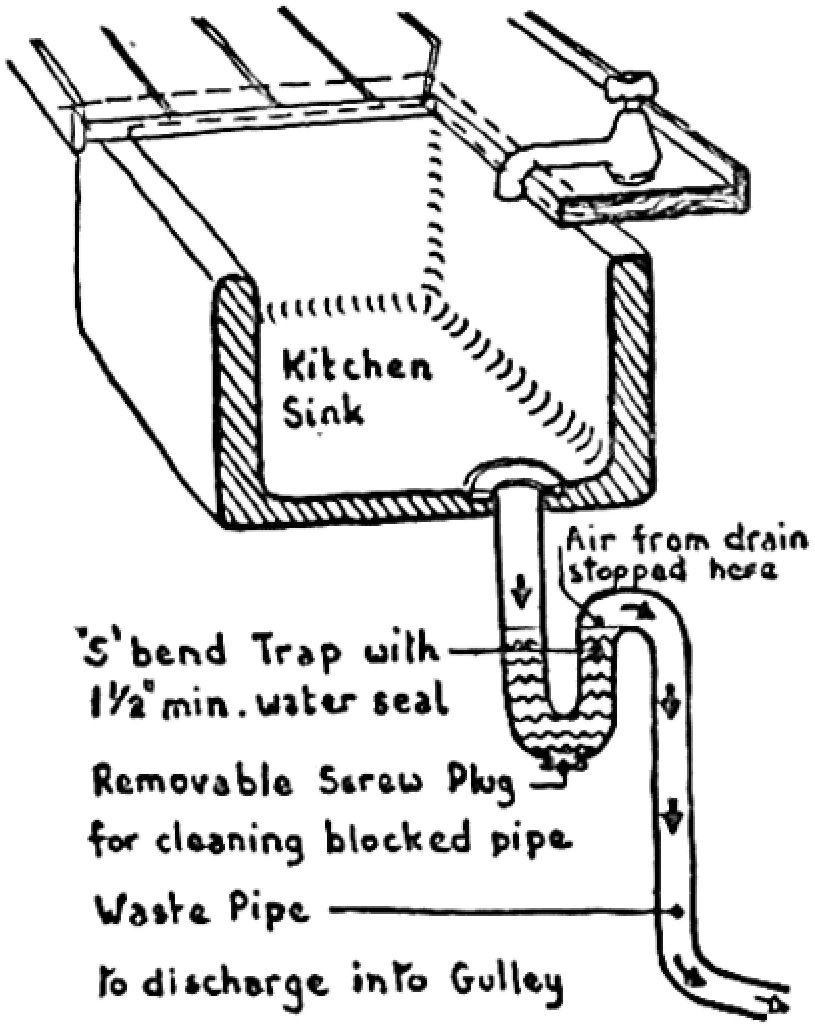
(*c*) *Waste Water from Water Closets.* Excreta, and the large volume of water used for flushing the water closets, passes through a syphon trap of a fairly broad diameter and, by means of a pipe through the wall of the house, into the soil pipe. It is

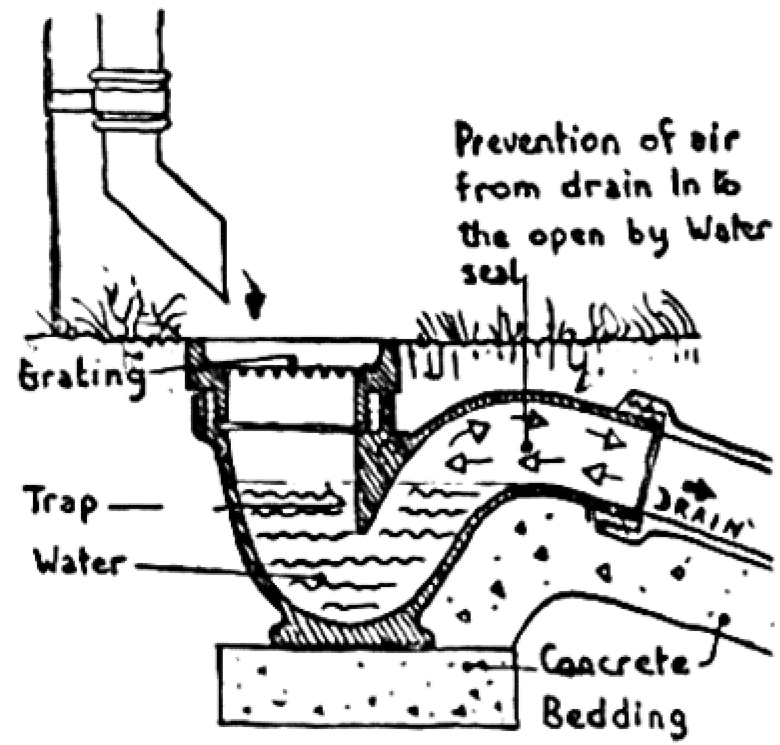
* * *

Fig. 4. How Drains Work. *Left:* Drainage from water closet showing the soil pipe with the upper portion forming the ventilating pipe. *Top left:* Section through a water closet showing how the water seal prevents harmful gases from coming into the house. *Centre:* Sink showing 'S' bend trap and screw plug. *Bottom right:* Grid and gulley trap.


Copper Wire Dome
Overflow from Cistern
Ventilating Pipe
W.C.
Soil Pipe
Damp Proof Course
Surface Concrete
Bend
DRAIN
Concrete Bed


Pipe from Flushing Cistern
Rubber Sleeve
Water Seal
Air Inlet to prevent Water Seal from being suctioned away
Soil Pipe


Kitchen Sink
Air from drain stopped here
'S' bend Trap with 1½" min. water seal
Removable Screw Plug for cleaning blocked pipe
Waste Pipe
to discharge into Gulley


Prevention of air from drain into the open by Water seal
Grating
Trap
Water
DRAIN
Concrete Bedding

essential that the pipe should not pass for any distance along interior walls or under floors, but be conveyed to the outer wall immediately (see Fig. 4). The soil pipe is so called because it goes down into the soil to join the main drain, and is not disconnected for ventilating purposes, as is the pipe from, for example, a sink. The upper end is, however, carried up to roof level, where the open top acts as a ventilator. A wire mesh is often fixed over the top to prevent birds nesting in the opening. Care should be taken that the soil pipe does not open under a window, on account of the danger of sewer gas.

It should be understood that any sanitary equipment which has an S-bend type of trap is liable to become blocked if unsuitable substances are put down the pipe. Much expense and inconvenience is caused if solid objects are so disposed of in water closets.

Drains and Sewers and the Disposal of Sewage

Drains are the pipes which convey waste water and sewage from each house, and are the property and responsibility of the occupier or house owner. The pipes are made of glazed earthenware in short lengths, one pipe fitting into the socket end of the next pipe in such a way that it can be cemented carefully into place and made watertight. The diameter of the pipe for an ordinary house should be 4 in., ensuring a rapid flow of water, which tends to stagnate if the pipes are too wide. The socket end of the pipe should be directed towards the flow of sewage and the pipes should be laid in as straight a line as possible with a fall of 1 ft. in 40 to 60 feet. They are placed in a trench and should be laid on a bed of concrete, unless the soil is so solid that there is no danger of subsidence when the earth is replaced. Any junction of drainpipes should be made in a V shape in one piece and not at right angles, so that water enters the drain obliquely. Before the house drain meets the sewer, it is once more trapped and inspection pipes and covers are arranged. (See Fig. 5.)

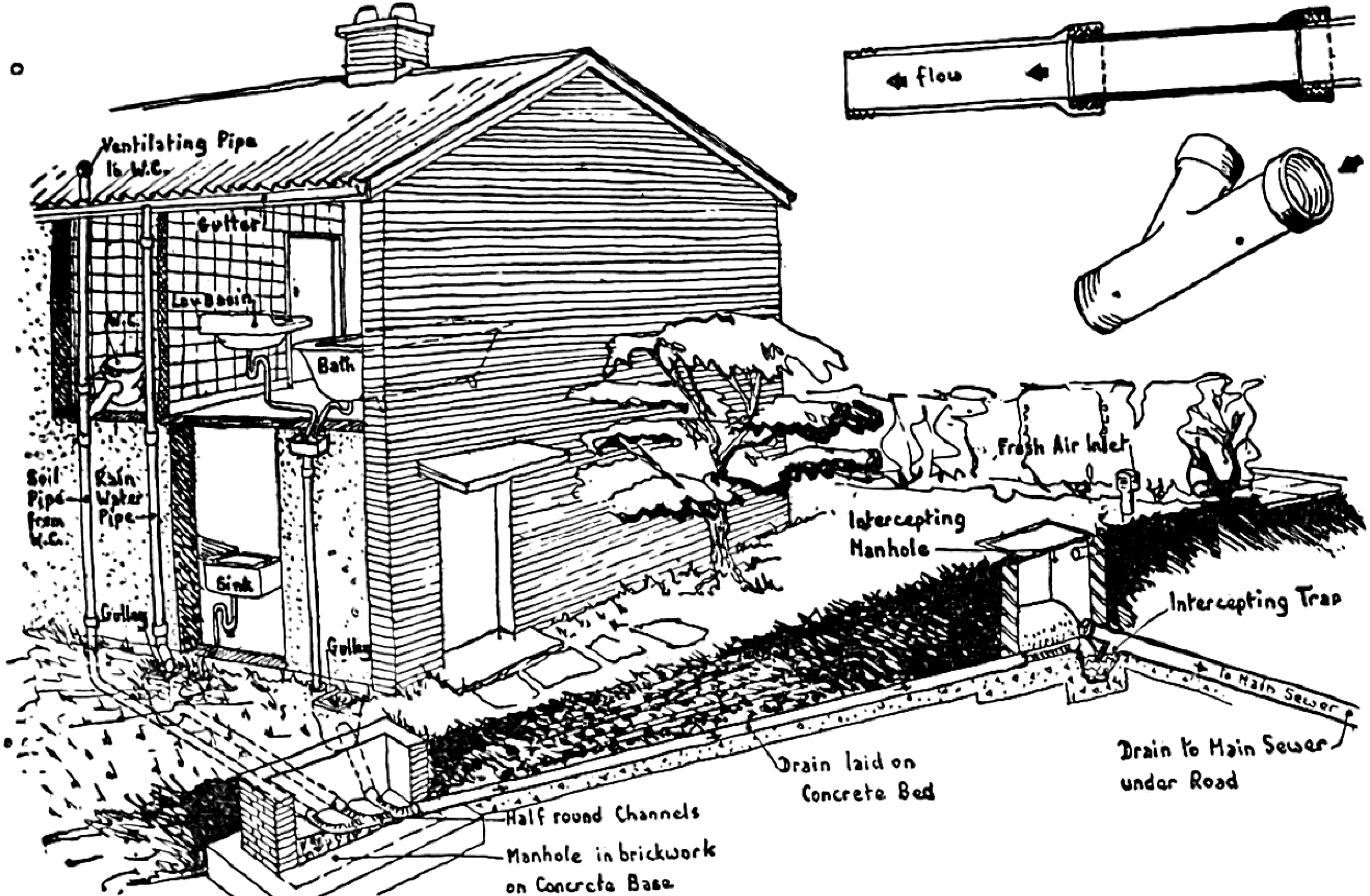


Fig. 5. How the House Drains Connect with the Sewers. Showing manholes and trap, and *top right:* How drain pipes are laid.

Sewers convey the water from several houses or premises and are the property and responsibility of the local authorities. They are usually situated in the roadways and the drain from the houses along the road join them. The sewers are made of glazed stoneware for residential districts, but where sewers of larger capacity are required they are made of brick embedded in cement and are pear-shaped. The fall of the sewers, and the velocity of the flow of sewage, must be carefully estimated by the civil engineers, and the whole problem of planning and laying sewers is a highly technical piece of work on which the health of the community depends. Manholes are placed at intervals along the length of the main sewers. The sewer is open at these points and may be inspected and cleaned. At junctions of sewers, pipes are erected which serve as ventilating shafts. The danger to health by sewer gas must always be borne in mind.

Disposal of Sewage. In the past, sewage has frequently been carried directly into rivers and has polluted these streams, making them unable to support animal or vegetable life and spoiling one of the natural beauties of the countryside. This crude method should never be adopted, and liquid and solid waste should not be passed into rivers until it has been treated and harmful organic substances removed. Another method, used by towns and cities on the seacoast, is to carry the sewage out some distance into the sea. The immensity of the sea and its disinfecting power makes this one of the best methods of sewage disposal. There is, however, some danger that at the low tide, sewage may be washed ashore; and bathing near sewer exits at low tide should be avoided. Those towns that have not this facility dispose of sewage by biological means and by filtration, the two methods being combined. Sewage may be passed over suitable land in rural areas and, by aeration and the action of bacteria, the organic substances are broken down into their natural elements and are used for enriching the soil, the water being drained off as a clean fluid into rivers, etc. Alter-

natively, the sewage is treated biologically in large tanks and, after a certain time to enable liquifaction by living organisms to take place, the sewage is filtered on to land in the form of sludge and is used after still further decomposition to increase the fertility of the land. It is obvious that these methods require great care and scientific planning and handling by the local authorities. The danger of sewage which contains disease germs polluting the water supply is a real one and no shallow well should be placed near to a sewage farm or any sewage-disposal unit.

In the country, where there is no sewage system as in towns for the collection and disposal of waste water, it is frequently allowed to run on the earth and soak in. Polluted water thus disposed of may find its way into surface wells and cause disease. One of the most usual methods of sewage disposal for small houses in the country is the use of cesspools. The liquid refuse is carried by means of pipes to a pit some distance from the house; the pit is carefully bricked and cemented in order that the ground in the vicinity may not be polluted. The solid substances are broken up by bacterial action and a pump is required to empty the cesspool periodically, the sludge being deposited on the land. Septic tanks are in common use in well-designed country houses. The sewage is carried to covered tanks, where the breaking up and liquefaction of the sewage is brought about by the multiplication of organisms already present.

4

Ventilation

VENTILATION is necessary in dwellings and buildings used by both man and animals to keep the air fresh and so maintain the supply of oxygen, without which life is impossible.

By the mere fact of living and breathing, we use up the oxygen in the atmosphere and, at the same time, emit carbon dioxide and other waste products that are harmful to ourselves and to others, if breathed.

A comparison of the composition of inspired and expired air will show the close relation there is between the proportion of the two gases:

Inspired or Atmospheric Air	%	*Expired or Vitiated Air*	%
Nitrogen . .	79·00	Nitrogen . .	79·00
Oxygen . .	20·96	Oxygen . .	16·5
Carbon Dioxide .	0·04	Carbon Dioxide .	4·5

It will be noticed that expired air has not been deprived of all its oxygen during its passage through the respiratory tract, which accounts for the fact that the same air may be re-breathed over and over again, e.g. by a person in an airtight room. It is only after some time that harmful effects would be noticed, though inevitably the oxygen would gradually be used up and a point reached where life could not longer continue. The production of carbon dioxide has a physiological basis which must be understood. It is explained in Chapter 21.

Composition of Air

The chief gases found in the air are the following:

(*a*) *Nitrogen*, an inert or inactive gas whose purpose seems to be the dilution of oxygen. It is unaltered during respiration.

(*b*) *Oxygen*, necessary for life and for combustion. Where the amount of oxygen in the air is deficient, health is affected. If the amount could be increased, the tempo of life would become too rapid and the body would wear out or burn out quickly, though temporary increase is given medically in some cases. The most important process by which the amount of oxygen is kept constant in the air, is the giving out of oxygen by plants in sunlight during the process of photosynthesis, while, at the same time, absorbing carbon dioxide. An atmosphere containing oxygen is only possible on a planet where vegetation is present.

(*c*) *Carbon dioxide*, produced by the combustion of carbonaceous materials either in the tissues of the body or in the burning of such organic substances as coal, wood, paper, fat, etc. In the body, carbon is present in food. All organic substances contain carbon, and will burn, though some more readily than others, and will produce heat and light.

There are some rare gases in very small proportion in the atmosphere; they are helium, neon, argon, crypton and xenon. Seaside and country air may also contain traces of ozone. The atmosphere also contains water-vapour in variable quantities, from saturation point in a damp, muggy climate, to a small quantity only on a dry, sunny day. In breathing, a large amount of water from the lungs is exhaled daily, the expired air being saturated with water-vapour. The exhaled water-vapour has a harmful effect upon the air of a room; it causes discomfort since, in a damp atmosphere, the water secreted by the sweat glands of the skin does not evaporate readily and the body temperature rises. The amount of water-vapour present in

a living-room, shown by steamed windows and in extreme cases damp walls, can be taken as an indication of the impurity of the air.

Impurities in the Air

Carried in the atmosphere are small particles of organic and inorganic substances, light enough to be suspended for some time and known as dust. Inorganic substances include particles of rock, soil, cement, salt and even volcanic dust; organic substances are pollen, bacteria, minute single cell organisms, such as yeast, wool and vegetable fibres and cells from the hair, skin and lungs of men and animals. It is the organic waste substances breathed from the lungs that are particularly harmful in ill-ventilated rooms used by a number of people, and it is they which give the room the disagreeable odour which we associate with stuffiness. The two other harmful substances, carbon dioxide and excess water-vapour, are both odourless and it is difficult to detect their presence, but the stuffiness of a room noticed when first entering it is an infallible indication of the bad state of the atmosphere. The amount of carbon dioxide present in a room forms the scale by which the purity of the atmosphere is judged.

It has been seen that the amount of carbon dioxide in atmospheric air is 0·04 per cent. and in expired air 4·5 per cent., so that if the same air were to be breathed without fresh air being introduced the percentage of carbon dioxide would gradually increase and the oxygen decrease. Even when there is an interchange of gases, this increase of carbon dioxide takes place and if the amount rises to 0·06 per cent., the air is at the limit of purity, giving a narrow margin of 0.02 per cent. between fresh and stale air. After much experiment, it has been found that in a space containing 1,000 cu. ft. of air, a man breathing for 20 minutes will add this additional 0·02 per cent. of carbon dioxide to the atmosphere and, if he were to remain in this space, it would be necessary to change the air every 20

minutes in order for the condition of the air to remain healthy. This emission of 0·02 per cent. of carbon dioxide is accelerated by exertion since more carbon is consumed in the tissues, respiration is hastened, and more carbon dioxide produced. For this reason, those who may be forced to spend some time in a small space are advised to rest quietly to conserve their supply of oxygen. It has also been ascertained by experiment that the amount of water-vapour in a closely confined space adds to the discomfort and distress felt, but that if the air can be kept moving by fans, the effect is less noticeable owing to the slightly more exhilarating effect of air impinging upon the skin.

The products of respiration tend to remain round the body and do not disperse quickly, for which reason a certain number of cubic feet of space per head should be allowed in dormitories and classrooms, nor does this allownace serve its purpose if the inhabitants are clustered closely together, say, at one end of the room. Moreover, the floor space surrounding the individual must be measured and the fact that a room has a very lofty ceiling and would, therefore, appear to be adequate, must not be unduly taken into consideration. Persons massed together out of doors in dense crowds have been known to faint for want of oxygen.

It should be noted that people who are anæmic that is, those whose red blood corpuscles contain insufficient hæmoglobin to combine with the oxygen they require (see Chapter 21) are always the first to notice and suffer from the effects of crowded, stuffy conditions.

The immediate effects of a vitiated atmosphere are experienced as restlessness, lack of concentration, tiredness and an inclination to yawn (Nature's effort to get more oxygen) and headaches. The effects of continually and habitually breathing impure air are very serious, since the whole of the respiratory and circulatory systems of the body and, ultimately, every living cell will suffer. The germs of disease abound in warm air and, since resistance is soon lowered, the body will quickly

fall a victim. All the respiratory diseases of the nose, throat and lungs, from the common cold and catarrh to tuberculosis, may result, and general debility and the waxen pallor of the face that goes with gross overcrowding can be seen. Air that is impregnated with very fine dust, far in excess of the normal, also has its dangers if breathed constantly; the disease of silicosis of the miner due to fine coal dust is an example. Special provisions are made under the Factories Act to minimise similar dangers in trades liable to them.

5

Ventilating Devices

VENTILATION of rooms has been shown to be essential to health. Although air follows the law governing the movement of gases—namely, that they move from areas of high pressure to areas of low pressure, this natural movement may be almost non-existent in buildings and is therefore insufficient unless it is assisted by careful ventilation.

We know that if each person using a room is provided with 1,000 cu. ft. of air and is moving and breathing normally, the air will require refreshing and changing in 20 minutes, and that if this is not done the carbon dioxide present will pass the limit of 0·06 per cent. The problem of ventilation, therefore, is to change the air of living rooms approximately three times an hour without causing draught and discomfort to the occupants.

There are two different methods of ventilation; natural and artificial.

Natural Ventilation

By this is meant the use of the natural movement of air and the normal features of a living-room. Gases, including air when heated, become less dense and are displaced by colder and heavier air and are forced to rise. Since expired air is at body temperature, it will move upwards and should be removed at the top of a room; therefore, exit ventilators should be placed high up in rooms and windows. The entrance for fresh air should be arranged towards the bottom of a room, but it will be found, in practice, that cold air will enter at any point if pressure is lower inside than out. If there is no exit for the used air and it

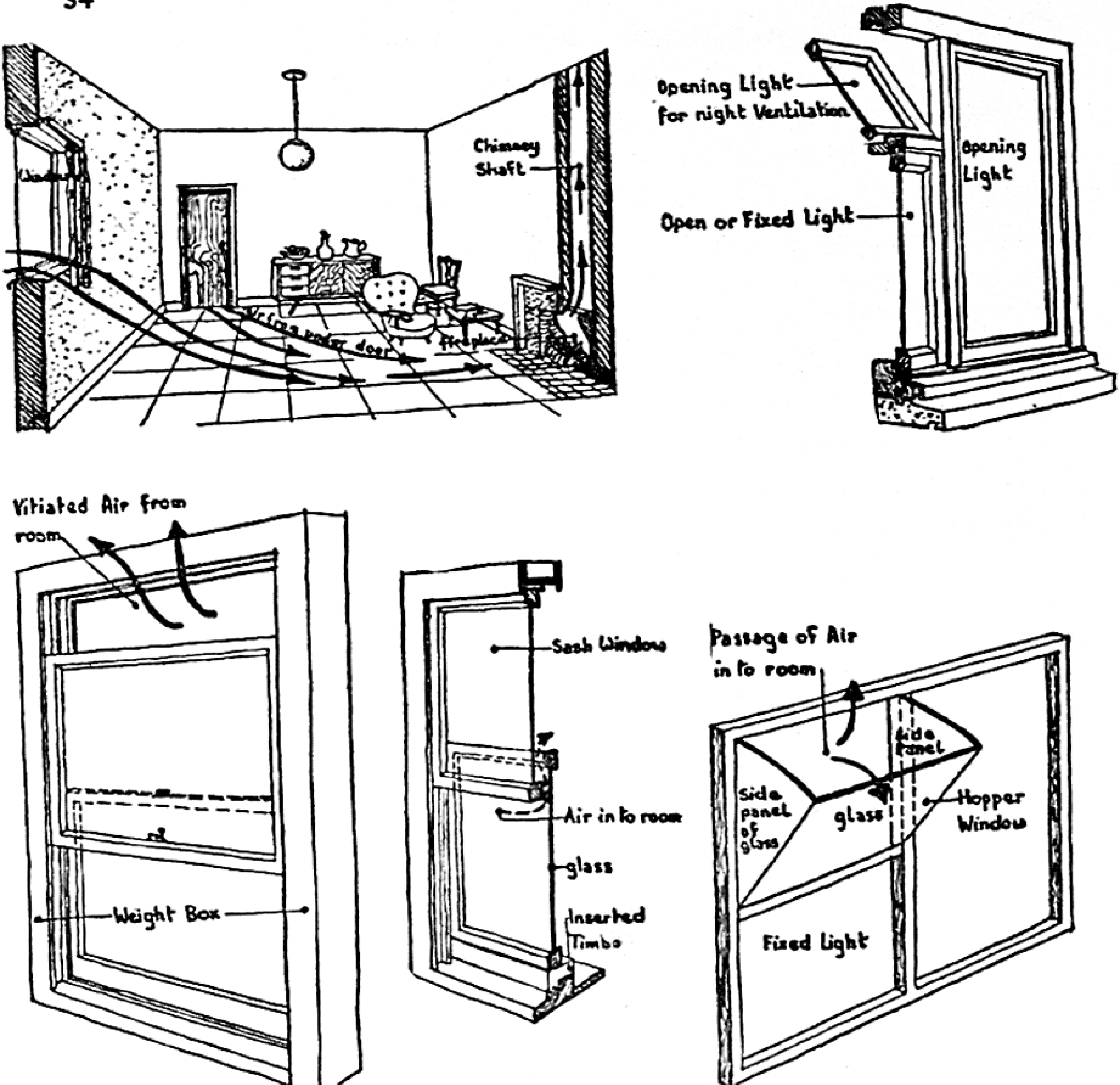


Fig. 6. Natural Ventilation. *Top left:* Ventilating effect of fire and chimney shaft. *Bottom left:* Top of window used as exit for air. *Bottom centre:* Hinckes-Bird's Ventilator. *Top right:* Window ventilator. *Bottom right:* Hopper inlet.

becomes chilled, it will sink again, since air heavily laden with carbon dioxide is heavier than pure air. However, it may usually be taken for granted that the purest air is at the lowest level and, in the extreme case of a man trying to escape from a smoke-filled room in a burning building, his chances will be

vastly greater if he crawls along the floor with his head held as low as possible. (See Fig. 6).

Normal Features of a Room. (*a*) *The Door.* Air will enter through the doorway and through the chinks and crevices when the door is shut, especially if there is a fire burning in the grate. If the door leads outside the house, the entry of air will cause draught and discomfort; if the door leads to a corridor, the air entering is not as pure as that from the outside and, since it is probably warmer and more nearly the temperature of the room, its entry will not be so rapid. Although any means of changing air is useful, reliance on the door as a means of ventilation is not the best.

(*b*) *The Chimney.* The chimney is a natural outlet only, even though it is set at a low level in a room. If owing to the situation there is a down-draught, the smell of soot is noticeable and, if there is a fire burning, it will smoke.

The chimney acts as a ventilating shaft; when there is a fire burning, a continual column of heated air passes up the chimney and air enters the room from windows and doors to take its place. This sometimes causes an uncomfortable draught at floor level and the ventilating effect of the pure air is lost if it is immediately carried up the chimney. The effect of a fire burning in a grate, however, is very noticeable in improving the atmosphere of a sick-room, and where a patient is confined to bed for some time a coal fire, it does not matter how small, is almost a necessity.

Even when there is no fire in the grate, the air in the chimney rises, being sucked out by the wind blowing across the mouth of the chimney pot; this process is known as perflation. Again, fresh air enters the room to take the place of the air extracted. The presence of an open grate in a bedroom is a most desirable feature and the chimney should never be blocked up.

(*c*) *Windows.* Windows whether sash or casement windows are the most suitable means of ventilating a room, as they give immediate contact with the fresh air.

As vitiated air tends to rise towards the ceiling, windows open at the top are best used for getting rid of stale air, and at the bottom for the entrance of fresh air. A *sash window* lends itself to such control, but it should be realised that only half the window space is available. *Casement windows* are often in pairs, half opening to the left and half to the right and can be regulated according to the way of the wind. In many modern houses, only a portion of the casement opens and a ventilator is fixed above. Exit ventilators fixed in the top of windows also allow air to enter, and they should be so planned that air is deflected upwards towards the ceiling, instead of downwards on the heads of those sitting below.

Devices Fixed in Windows. (*a*) *Hinckes-Bird's ventilator* is applied to small sash windows and is useful for ventilating bedrooms where the bed is placed beneath the window. A strong lath of wood, as long as the window is wide, is placed in the lower sash frame reaching from side to side. The window is then pulled down on to the lath, leaving a gap between the upper and lower frame through which air will enter. (See Fig. 6.)

(*b*) *Cooper's Ventilator.* Holes are perforated in the glass of the upper part of a window. Over this is placed a movable disc of glass or mica, or metal, with similar holes. This disc can be turned to open or close the apertures.

(*c*) *Hopper Inlet.* A glass pane hinged at the bottom is placed at the top of a window or door, sloping inwards with side panels, to prevent a downdraught. Alternatively, the inlet is placed at the inner side of the frame at the bottom of a sash window. When the inlet is open, the hopper protects those sitting close to the window from immediate contact with the entering air. (See Fig. 6.)

Wall Devices. Various devices are built into the walls of a room:

(*a*) *Wall Grating*. A grill or grating is placed high up in the wall open to the outside air and a similar grill is placed on the inside, with the occasional addition of a flap to act as a closing device. This is both an entrance and an exit for air.

(*b*) *Ventilating Bricks*. These have a series of funnel-like holes in them. They are built in the bottom of a building and are frequently used for ventilating the space beneath the floor-boards, although they may be placed in other positions.

(*c*) *Tobin Tube*. This is a tube or shaft built into the wall with a grating at the bottom leading outside and another at the top, connecting with the inside and placed fairly high up on the wall to bring in fresh air. Such tubes are somewhat old-fashioned for ordinary dwelling-houses and are more frequently found in meeting halls and large buildings.

In connection with central heating, an air inlet is sometimes made leading from the outside wall where it is covered by a grating; the outlet into the room is placed immediately behind the hot-water or steam radiator and the air is heated by passing over the pipe entering the room without the possibility of a draught.

Double Ceilings. These are used in workrooms and factories. The ceiling is perforated with a number of holes. Above the ceiling is a space which is in contact with the open air on either side through gratings. The warm, vitiated air passes through the perforations and so out through the gratings. The movement is increased by the illumination being placed beneath the perforations, and in some old-fashioned theatres and halls, the candelabra and the highly ornamented ceilings were part of the ventilation scheme.

ARTIFICIAL VENTILATION

For large buildings, theatres, cinemas and offices and flats, artificial ventilation is necessary. Particularly in theatres and cinemas where people remain for several hours, with an

inadequate number of cubic feet of air per person and no window ventilation, the air becomes foul and overheated unless it is controlled. The two methods used are the extraction or exhaust system and the propulsion or plenum system. In some cases, both methods are resorted to when it is described as a balanced system. Where the air is cleaned, warmed and either dried or moistened, the term 'air-conditioned' is used to describe the system.

Where the first method is used, the air is extracted by means of fans fitted above the heads of the occupants. Open windows and other natural means may then supply the fresh air. Air can also be extracted by means of a furnace with a high chimney at the end of a shaft, as in a mine, the air from all surrounding parts being drawn to the source of heat, while fresh air is pumped in.

In the plenum system, the air is 'conditioned' by passing through a water filter to clean it, it is then warmed, its humidity adjusted, and it is passed into the rooms in specially adapted shafts. The combination of the two methods to form a balanced system is frequent in cinemas, theatres and luxury flats. This, however, entails that no windows may be opened to interfere with the balance of outgoing and incoming air, and its use cannot be encouraged for normal living conditions. Its continual use is found to have an enervating effect, as the constant temperature prevents the heat-controlling mechanism of the skin from coming into use and the occasional exhilaration of cool air on the skin is lost.

6

Heating Buildings

Heat Transference

HEAT is produced in everyday life by chemical changes, e.g. those which take place during burning, and by the passage of electricity through conductors.

Heat is transferred from its source by three methods: (*a*) radiation, (*b*) conduction and (*c*) convection.

(*a*) *Radiation.* Heat passes in direct rays from the burning object until it falls upon some solid substance which will absorb it. In their passage through the air the rays are not deflected. The intensity decreases in proportion to the square of the distance travelled from the source of heat.

Radiation of heat takes place from the sun, and from any glowing body such as coal and gas fires, and electric radiators.

(*b*) *Conduction.* Heat is transferred from the source by passing particle to particle throughout a solid object by contact with each other till the whole becomes hot. Some substances do not allow of the passage of heat readily, e.g. one end of a stick may be burning while the other is cold; other substances, in particular metals, allow the rapid passage of heat, e.g. a bar of iron; if the end of a poker becomes red hot in a fire, the handle also becomes hot enough to be uncomfortable to hold. This method of heat transference is made particularly obvious in kitchen utensils, etc., where wood or other bad conducting substances are used for handles of kettles, irons and so on. Bad conductors of heat are also used to avoid injury to delicate surfaces by hot articles; for instance, cork mats are placed on polished tables to prevent damage from hot plates, etc.

(*c*) *Convection* is the method by which heat is distributed

through liquids and gases. Here the heated particles expand, become less dense and rise, and colder denser particles sink to take their place.

Various Methods of Heating

Of the three methods of distributing heat, only radiation and convection are made use of in heating buildings.

Heating by Radiation. The coal fire, gas fire and electric radiator work on the principle of direct radiation. This is considered to be the most pleasant form of heat, as the rays have a direct impact on the skin, clothing and furnishings of the persons using the room, and it has a more stimulating effect than other forms of heating. Where, however, a room is large or those using it cannot sit near the fire, such heating is apt to be insufficient and inefficient. As radiation does not warm the air, but only the object on which the rays fall, there are no convection currents, so one is apt to be too hot in front and cold behind.

(1) *Coal Fires.* The open grate, particularly of the old-fashioned type with open bars, a wide chimney and a metal surround, has many disadvantages.

(*a*) The method is inefficient and wasteful. Much heat is lost up the chimney and combustion is imperfect.

(*b*) The amount of soot produced by imperfect combustion pollutes the atmosphere and helps to spread the palls of smoke over our large cities and industrial towns, which prevent the passage of the sun's rays and is conducive to ill health.

(*c*) The soot is deposited on buildings, streets, and on the houses and persons of the citizens. This entails constant washing and cleaning by the housewife and many thousands of pounds are spent annually by the local authorities in attempting to remove the dirt deposited by the domestic open fire and the factory chimney.

(*d*) The cleaning of grates and removal of soot, ashes and cinders gives much unpleasant and dirty work to the housewife.

(*e*) A brightly glowing fire and the apparent comfort of the hearth are often discounted by a severe draught at floor level and on the backs of the users. Draught is overcome in some modern grates by means of a flue, bringing the air directly from outside under the floor. Controls regulate the amount of air.

(*f*) An open fire may be highly dangerous to young children and a fireguard is, by law, compulsory. Pans and kettles of boiling water placed on fires and hobs are also most dangerous.

There are, however, a certain number of points to be considered in favour of an open fire.

(i) The often raw, damp atmosphere of these islands appears to be alleviated more by an open coal fire than by any other means.

(ii) The coal fire is cheerful and companionable and makes a focus for the family group.

(iii) The open fireplace, as we have seen, makes a useful exit for used air and assists in ventilation.

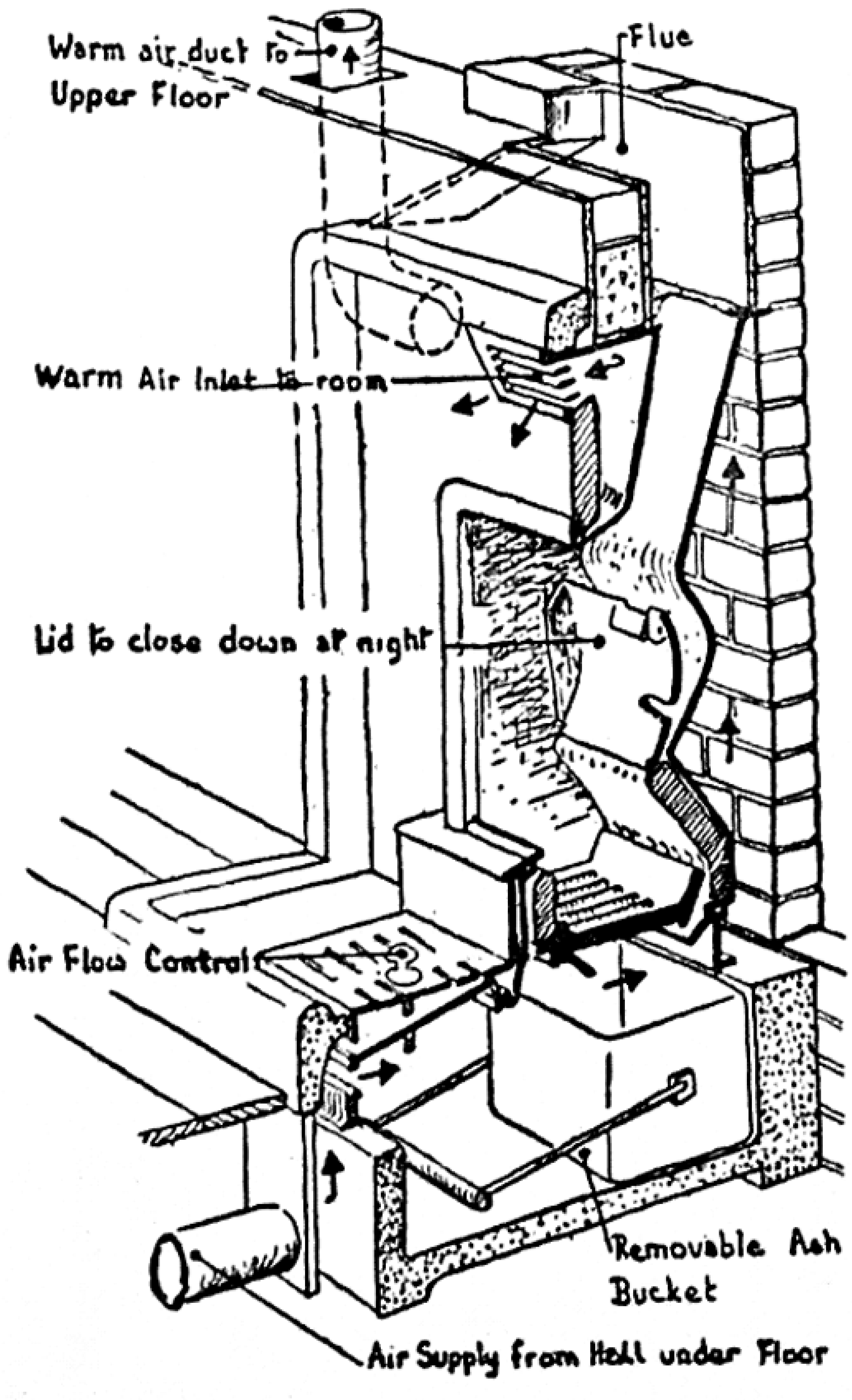
(iv) The open fire serves other purposes than heating which, particularly in small cottage homes where the kitchen is the living-room, is an important point. The fire will heat the water, serve for cooking, dry and air clothing, and burn rubbish.

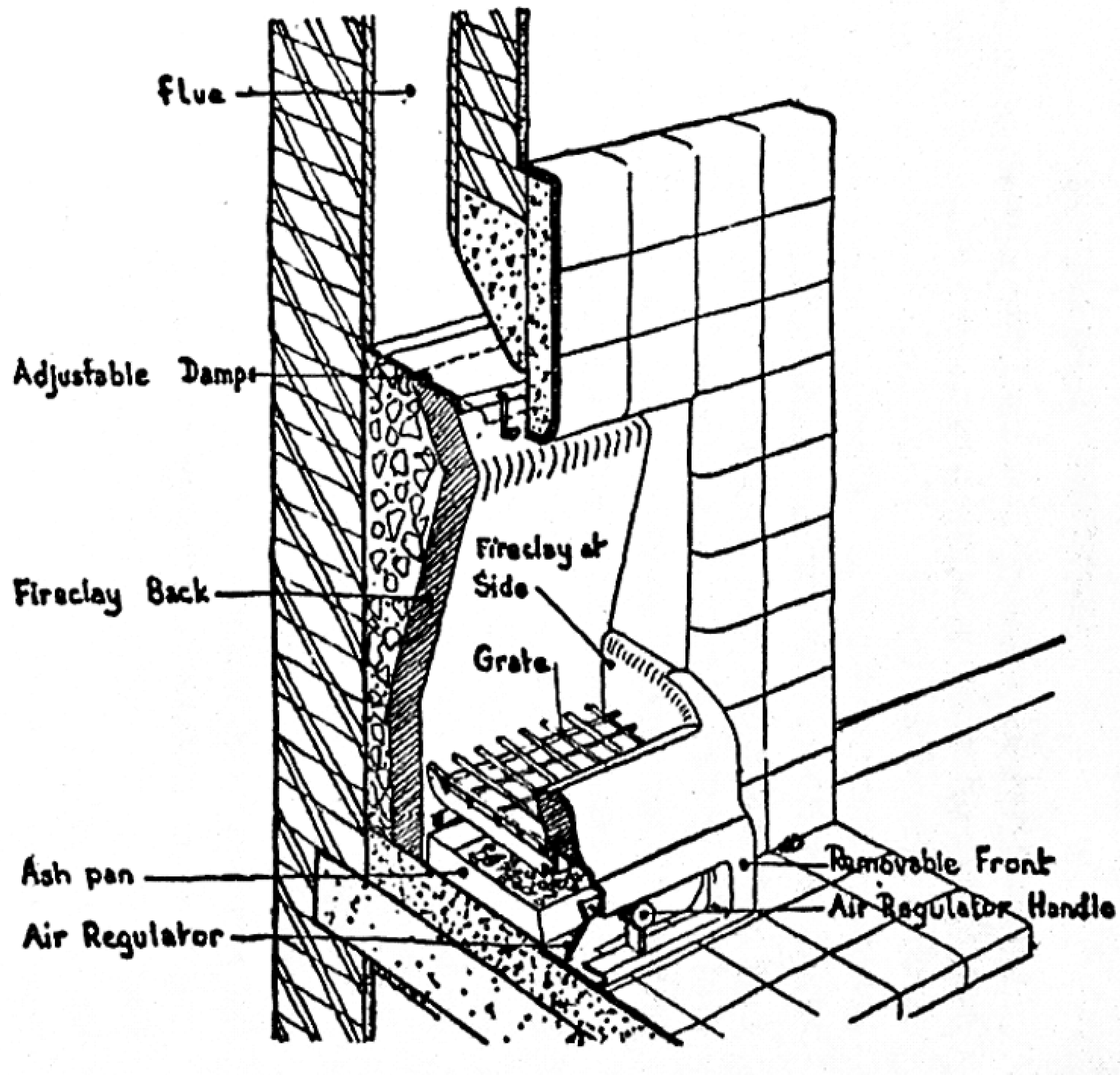
Since it has been found most difficult, even by smoke abatement propaganda, to persuade people that they should give up coal fires, the provision of well designed and smokeless grates must help towards solving the problem. The modern type of grate, therefore, has been devised which, it is claimed, will obviate most of the disadvantages.

(*a*) The grate is made without bars, with an adjustable air inlet and with a pan to receive the ash. If this pan is sunk below the hearth ash need not be removed more than once or twice a week.

(*b*) The grate is lined with fireclay, which throws out heat instead of absorbing it.

(*c*) The back of the chimney projects towards the room, with a small chimney space; this makes for the slower and more perfect combustion of coal.


Warm air duct to
Upper Floor
Flue
Warm Air Inlet to room
Lid to close down at night
Air Flow Control
Removable Ash
Bucket
Air Supply from Hall under Floor


Flue
Adjustable Damper
Fireclay Back
Fireclay at
Side
Grate
Ash pan
Air Regulator
Removable Front
Air Regulator Handle

(*d*) A draught regulator prevents too much air passing to the fire from the lower level.

Many new types of grates are being made which allow of the burning of smokeless fuels, such as anthracite and coke. Some of these can be fitted into an existing grate; others require special installation, and it is claimed that the cost, though higher, is soon saved by the smaller amount of fuel consumed. The continuous burning fire keeps the whole of a small modern house at a more even temperature and both comfort and cleanliness are increased.

Some new models combine radiant heat with convection by means of special warm-air outlets usually above the level of the fire (in some cases even in the room above), and all have fitments by which the entry of air to the fuel can be carefully controlled. It is by the gradual adoption of these specially constructed grates that our domestic smoke abatement problems may be solved. (See Fig. 7.)

(2) *Gas Fires.* Gas jets, having a well regulated supply of gas and air, cause 'radiants' to glow and these throw out heat by radiation. Gas fires are usually placed in existing grates, but portable gas fires are now obtainable that can be installed wherever there is a gas point.

(*a*) They have the advantage of being clean, require no work in maintenance, except dusting the enamel or metal fittings; (*b*) they throw out a considerable amount of heat quickly and are, therefore, useful for occasional heating of rooms, and (*c*) they are economical, as the gas can be regulated and cut off at once when not required.

A portable gas fire can, on account of its long metal flex,

* * *

Fig. 7. MODERN ROOM HEATING. *Right:* Modern slow-burning combustion grate showing details. *Left:* Modern slow-burning combustion grate providing radiant and convected heat. From it the hot air is led to a room above.

be brought to the exact area where the heat is most required, e.g. writing table, etc.

The disadvantages of gas fires are:

(i) They do not help in ventilation though, if placed in a grate with an open flue, there is some movement of air up the chimney.

(ii) Oxygen is used in the combustion of gas, and carbon dioxide is produced. Rooms heated by gas, therefore, require ventilation.

(iii) Some of the older types of fires dry the air.

(iv) Gas fires do not give the sense of comfort of the coal fire, although this feeling is a matter of habit.

(3) *Electric Radiators.* Radiators may be of two types, the fire-bar and the reflector. The fire-bar radiators are sometimes permanently installed in the walls about one or two feet from the floor; each bar is usually about 1 kilowatt loading, and one, two or three bars are used. The fire bars have separate switches, by which means the heat can be regulated. The bar type of radiator can also be portable. Reflector heaters are from 750 watts to about 2,000 watts. In these types the element is wound round a core of fireclay, as in the bowl fire, or it is a long coil with a trough-like metal reflector behind. The heat is radiated from the red hot element and from the fireclay in the bar fire, and is reflected by the copper or bright metal bowl or trough of the reflector type and so radiated to the room.

The advantages of electric radiators are obvious.

(*a*) There are no smoke, fumes or dust, and oxygen is not used.

(*b*) All the electricity paid for is given out as heat, and it can be switched off when not required.

(*c*) The radiators are convenient to handle.

The disadvantages are few:

(i) For continuous use, radiators are somewhat expensive, and other forms of electrical heating should be used.

(ii) They cannot be used for other purposes than heating and drying and airing clothes, as can a coal fire.

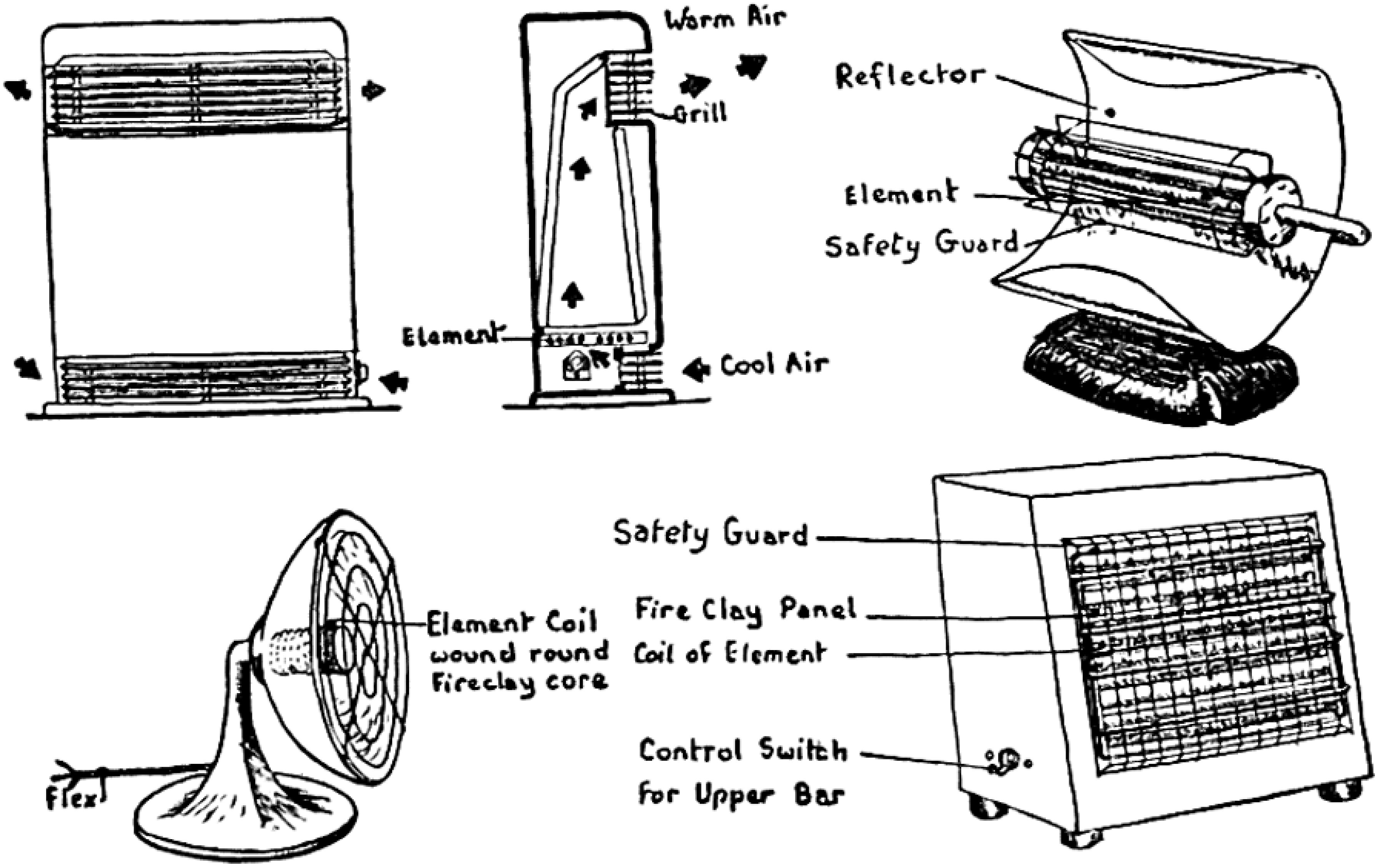


Fig. 8. HEATING BY ELECTRICITY. *Top left and centre:* Electric convector heater. *Top right:* Reflector fire. *Bottom left:* Bowl reflector. *Bottom right:* Two bar radiator.

Electric radiators and fires should always be fitted with proper guards to comply with the Fireguards Act.

Heating by Convection. Air is warmed by convection, providing a minimum heat throughout. This can be supplemented by fires, stoves, etc. The transference of heat by convection is made use of in (1) closed stoves, (2) convection heating by electricity, (3) central heating by water and air.

(1) *Closed stoves* are much used on the Continent and in halls and Army huts. The stoves are made of brick, tiled over, or of metal. Coke or anthracite is used, burning in an enclosed space which is connected by a pipe leading to the outer air for the removal of fumes. The surface of the stove becomes very hot and the air touching it becomes hot and less dense so that

cold air comes in to take its place and pushes it up. Thus convection currents are set up, and the whole room becomes of an even temperature. The temperature of the room will depend on the correct stoking and adjustment of the stove.

The advantages of closed stoves are:

(*a*) Smokeless fuel is used and the outer air is not polluted.

(*b*) Little dirt is produced internally, though the stoves do require cleaning. Stoking is only necessary at intervals.

(*c*) The heating is even and efficient.

(*d*) Since combustion is slow, the method is economical and coke which is somewhat cheaper than coal may be used.

The disadvantages are:

(i) Oxygen is used from the air of the room and, if there should be any defect in the stove or the pipe, carbon dioxide or carbon monoxide may enter the room. Carbon monoxide being a highly dangerous and odourless gas, has been responsible for the death of persons sleeping in bedrooms inadequately ventilated and heated by closed stoves.

(i) The air is dried. To remedy this it is common to place a bowl of water near the stove, though it is doubtful whether this has any real advantage.

(iii) The enclosed nature of the stove does not aid ventilation.

(2) *Convector Heaters.* Electric convector heaters, in cabinet form, can now be obtained and, when placed in halls and corridors, they heat the air in the whole of the house by convection currents and take the place of central heating. Their use is only suitable for small buildings, as the number required for large spaces would not be economical.

The heating element is so arranged that air passes over it and, being warmed, leaves the top of the convector, cold air entering at the lower level. Such appliances are simple to use, efficient, clean and inexpensive, but they are more suitable for a central position in the home than for use in each living room although, in nurseries, their complete safety is a point in their favour. Convector heaters are largely used in maintaining an even

temperature for example in the premature babies' unit of a hospital.

(3) *Panel Electric Heating*. The use of electricity for large-scale heating will, in course of time, probably supersede the low-pressure water pipes and radiators. Flat metal panels containing heating elements are fitted along the walls of the rooms about 2 ft. from the ground, the glowing element is covered and, in some cases, the panels are hidden in the wall. The air is warmed by convection as it comes into contact with the panels, and is distributed throughout the room. The amount of panelling and the position must be calculated by heating experts, according to the cubic capacity of the room. The heating elements can be thermostatically controlled so that when the air of the room reaches the correct temperature, the electricity is automatically switched off, coming into operation again when the temperature falls. This method has all the advantages of cleanliness, ease of use, infallibility and complete efficiency. Expense in running and the lack of ventilation are the only disadvantages of this method. Tubes containing heating elements are used in the same way.

In some cases, electric panels and heaters are placed beneath the floors and, in others, in the ceiling; the latter cannot be described as convection heating, but is rather radiation.

(4) *Central Heating*. Heat transference by convection is made use of both in supplying the heat to the room and in distributing it. Rooms are heated by (*a*) hot-water pipes and radiators, (*b*) by pipes containing hot air or steam and radiators.

(*a*) *Hot-water Pipes*. A furnace and boiler are required with an enclosed circulation of water distributed by means of pipes and passing through radiators fixed in the rooms. It is essential that the system should be installed by heating experts in order that the size and number of radiators may be apportioned correctly to the cubic capacity of the rooms. The furnace, usually burning coke or other smokeless fuels, is installed in the basement of the building, with an adequate boiler placed above

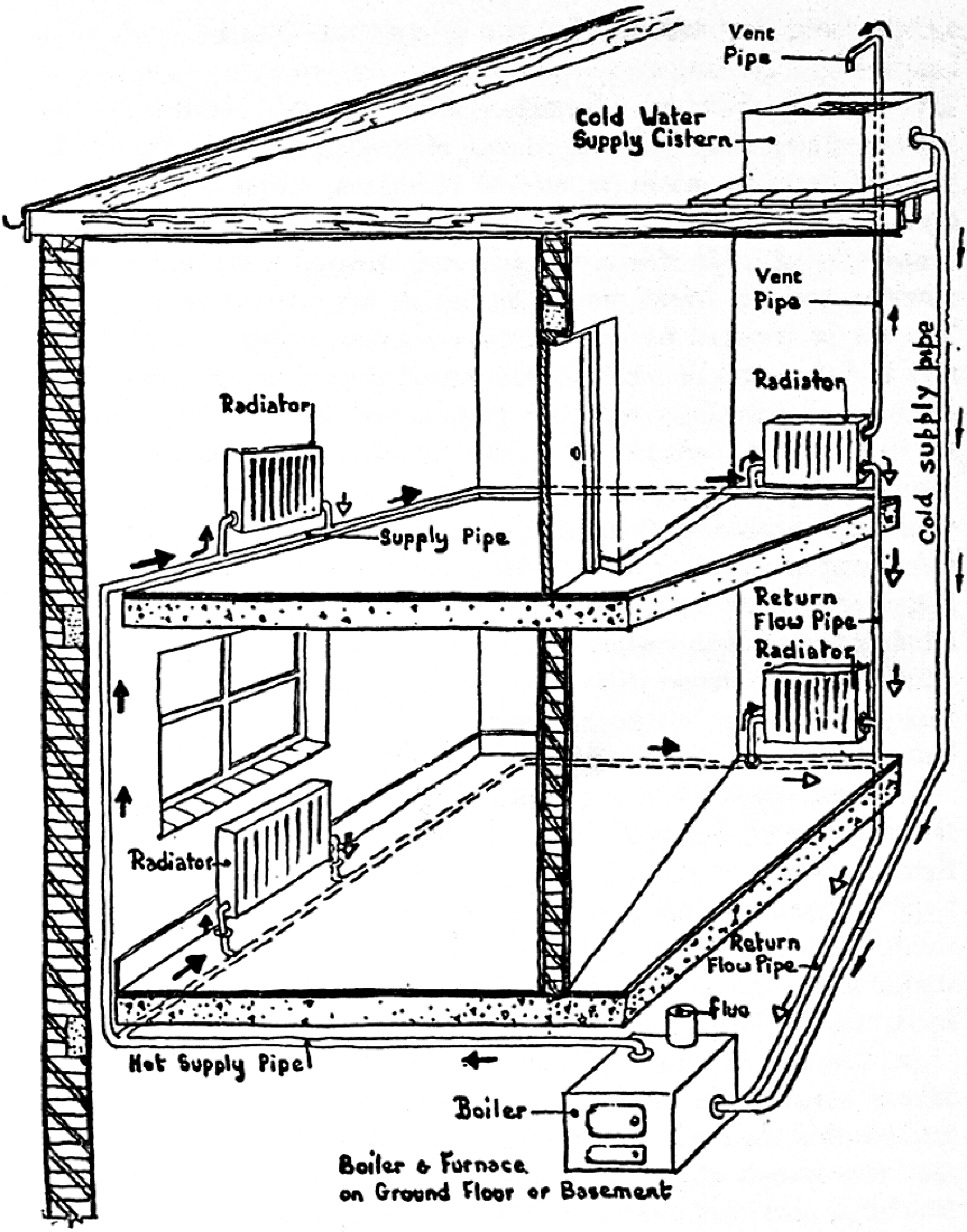


Fig. 9. Central Heating with Hot Water Pipes. Showing how the hot water circulates and how cold water is added to the system. Note the expansion pipe.

it. The water in the boiler is heated by convection currents which cause the water to rise to the top of the boiler and to be forced out into the distributing pipes, which convey it to the various floors of the house. The hot water heats the pipes and radiators and the air passing over their surface is heated, convection currents are set up, the air rising to the colder parts of the room, the colder air taking its place coming into touch with the radiators. The cooled water then returns by a further length of piping to the bottom of the boiler to be heated again for further use. By this method, the air of the room gradually becomes of an even temperature and it is most effective for large rooms occupied by numbers of people. The heating of buildings is therefore carried out in an efficient and inexpensive manner; little or no dirt is produced and draughts are controlled. It is necessary that a supply of fresh cold water should be obtainable and water from a cistern also enters at the bottom of the boiler to replenish waste. It is also essential that there should be an outlet for hot water and for steam, called the vent pipe, and this is usually placed over the cistern. If this were not the case, the pressure of steam produced by overheating the water might burst the boiler and cause a dangerous explosion. (See Fig. 9.)

On the reverse side, centrally heated rooms are apt to be stuffy and ill ventilated, unless the method is combined with artificial ventilation. The even temperature of the air is not exhilarating to the skin, particularly if all parts of the house are evenly heated, and there is consequently a loss of skin adaptability. In towns, the walls behind radiators sometimes become darkened by the dust in the air passing upwards, and a shelf, or other fixture, is placed above the radiator to prevent this. A certain amount of care and skill is required in stoking and cleaning the furnaces, without which the system is useless. To aid ventilation, it is advisable to have entries placed in the walls behind the radiators, so arranged that the fresh air entering will pass over the pipes and enter the room warmed,

thus avoiding either draughts or stuffiness. This method, however, entails a greater expenditure on fuel, on account of the heat loss from the radiators.

(*b*) *Steam Pipes* are not much used for heating, except in works and factories, where steam is to be had readily and where its use is an economy. In America, the method is frequently used for large buildings, the principles of convection currents and the even distribution of heat being the same as those of the hot-water method of central heating.

Fuel oil is used in central-heating systems for both houses and factories, etc., where it is felt desirable to cut labour costs. The fuel oil is delivered by tanker lorries direct to the oil reservoir which is incorporated in the system. Any desired temperature may be obtained by a thermostatically controlled device on the boiler.

District Heating. It is possible that in the future heat will be distributed to the householder on a large scale from a central source. Waste heat from generating stations can be used for heating water which can be supplied by means of pipes, to all the buildings in a district, just as gas and electricity are at present provided. By this method hot water for central heating and for washing purposes can be obtained at a cheap rate. The initial expense of installation has, however, prevented the method from becoming widely used.

7

Water Heating

WATER is heated by convection currents, set up by particles of water, as described in the previous chapter; it is the method by which heat is applied to the water and the heated water distributed about the house.

Methods

Small quantities of water are heated by being placed in a kettle, pan or similar vessel over the flame of a fire or gas burner, or on an electric hot plate. Electric kettles are also used; these contain an element in a coil shape, well insulated, which is either immersed in the water inside the kettle or clamped to the bottom of the kettle, the former being the quicker and more efficient type. The usual wattages are 1,500 watts for a 3-pint kettle, to 1,800 watts for a larger size. There are several methods of heating water on a large scale for baths, washing and washing up, etc.

(1) *Coal-fired Boiler*. This is perhaps the most usual method, except in the most modern electrically-equipped home. The boiler is made of iron, and holds only a few gallons of water. The water enters at the bottom of the boiler from a cistern, always placed at a higher level, in order that there may be a gravitational flow into the boiler. The boiler is often placed behind the kitchen fire, and there is direct connection by a wide flue which leads under the boiler to the chimney beyond, the hot air from the fire heating the boiler. A damper which opens or shuts the flue regulates the heat, by controlling the draught. The heat sets up convection currents in the particles of the water, the cold displacing the heated water which rises through

the pipe to the hot-water cylinder, or tank, containing 20–30 gallons, near the kitchen fire or in a room immediately above, e.g., the bathroom. The hot water enters the cylinder at the top, while the pipe from the bottom takes cooler water back to the boiler, thus providing a continuous circulation of water from the boiler to the cylinder and back. The cylinder is usually placed in a cupboard, which is frequently used as an airing cupboard, but a large amount of heat is lost from the surface of the cylinder by conduction to surrounding air. It is, therefore, a distinct saving to have the cylinder padded or lagged with some non-conducting material, such as cork or asbestos; this will result in economy in fuel and in a better hot-water supply.

The cylinder is connected to the hot-water taps by piping and, when the taps are turned on, hot water is available. As the hot water is used, fresh cold water enters the bottom of the boiler, and so maintains the supply. If the water in the boiler becomes very hot, a certain amount of steam is produced, and should there be any blockage in the hot water system, the high pressure with no outlet will cause an explosion. This may occur in cold weather when a length of piping becomes frozen and blocked with ice. Where there is no flow from either the hot or the cold-water tap, such a blockage is to be suspected, and the fire should be extinguished, for a dangerous and destructive explosion of the kitchen boiler may follow. As a safety precaution, there is a vent pipe from the top of the cylinder, as explained on page 49.

To obtain hot water from a coal fire and boiler: (*a*) the flues must be regularly and properly cleaned, (*b*) the damper must be pulled out, (*c*) the fire must be built up some little time before the water is required and (*d*) too much water must not be drawn off before the water in the cylinder has become hot.

(2) *The Domestic Heating Boiler.* This type of boiler is used in many kitchens where there is no fitted fireplace with a boiler placed behind it. They burn coke or other smokeless fuel, and have an outlet pipe for fumes carried into a chimney. The

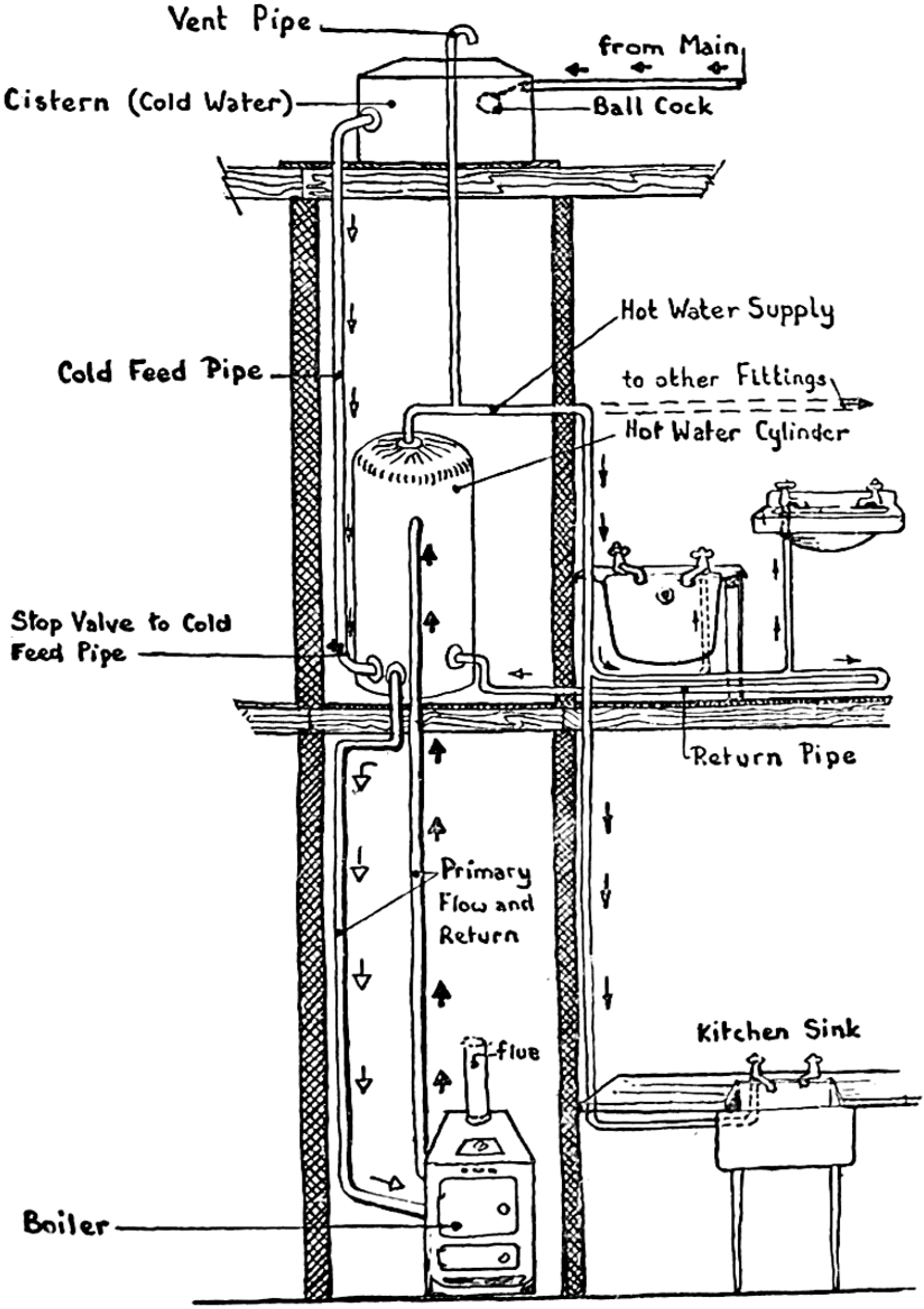


Fig. 10. HOT WATER SUPPLY FROM A BOILER. Showing how cold water comes through the mains and the hot water reaches the taps.

boiler more or less surrounds the fire and the hot water is stored in a cylinder or tank in the ordinary way. Such stoves also warm the room in which they are placed by convection, although they cannot take the place of a coal fire for family use as far as cheerfulness is concerned. (See Fig. 10.)

(3) *Electric Immersion Heaters.* As an addition to the hot-water boiler or in place of it altogether, immersion heaters are frequently placed in cylinders originally intended for the method just described. A popular type of immersion heater is in the form of narrow tube of copper or alloy, containing the element carefully insulated. (See Fig. 11.) The tube is immersed in the water, and, when the electricity is switched on, the heat from the wires passes through the insulation and the metal to the water. Convection currents are set up in the water in the cylinder until it all reaches an even temperature. Another type of heater is in the form of a thick tube inside which is a removable core of porcelain, round which the element is wound. This core can be removed for repair or renewal, which is an advantage. Immersion heaters consume a fairly large amount of current, being loaded from 1,000 up to 3,000 watts and, since there is every likelihood of forgetfulness and extravagance in their use, they are thermostatically controlled by a piece of apparatus based on the principle of the expansion of metals when heated—that is, the circuit is cut off at a predetermined heat. The desired temperature of the water is decided upon: for baths, usually 97–107° F., and up to 160–180° F. for other purposes; 140° F. is a good all-round temperature. When the water reaches this temperature, the electricity is automatically switched off; when the water cools below the temperature, the electricity is automatically switched on again. There is a differential or gap of up to 10° F. between the switching on and cutting out temperatures.

Self-contained Heaters. The method just described can also be used, and more efficiently, for small self-contained heaters for

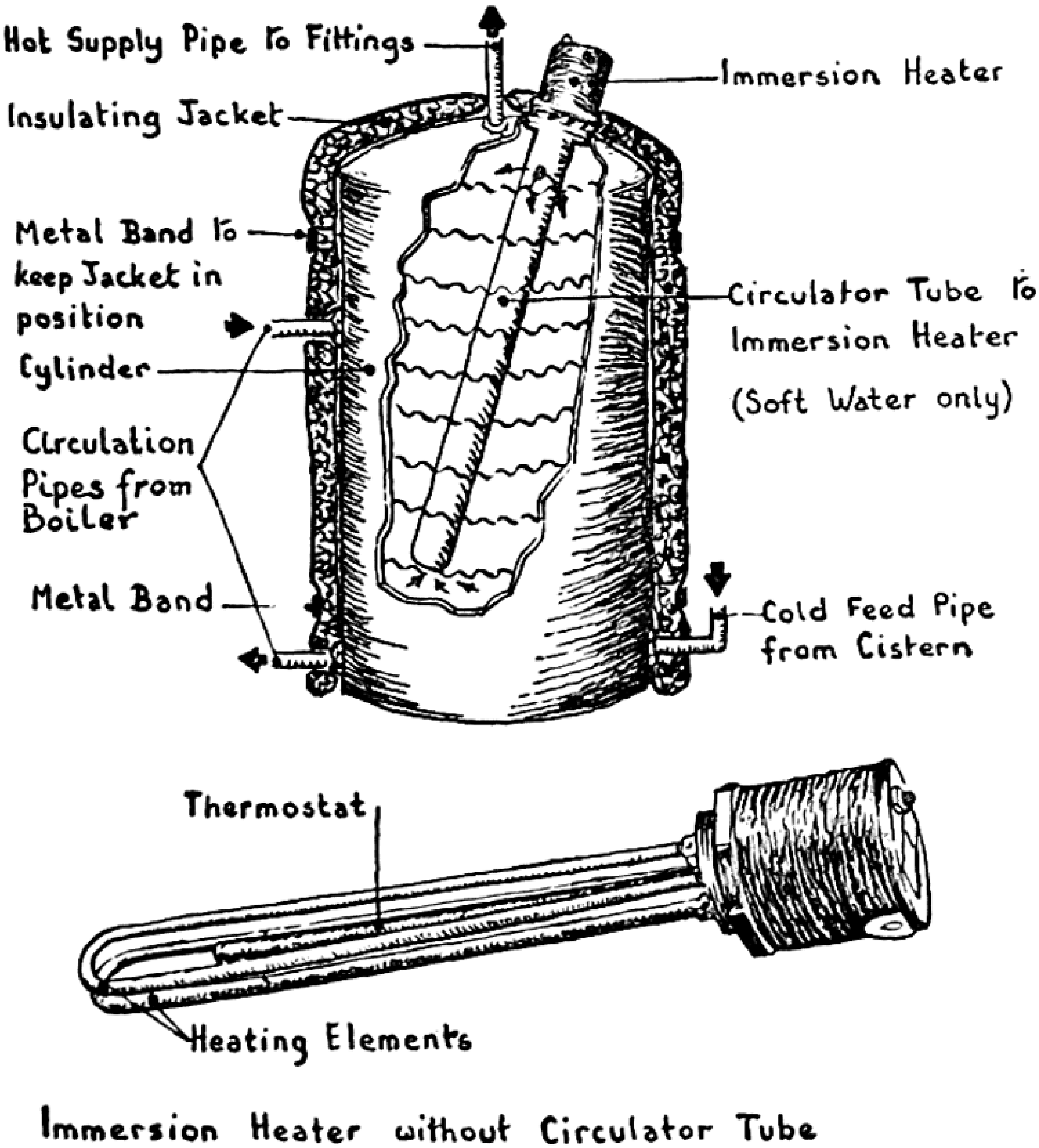


Fig. 11. Hot Water by Electricity. Showing hot water cylinder and immersion heater.

placing above the kitchen sink—holding $1\frac{1}{2}$ to 3 gallons of water, or larger heaters holding 20 to 30 gallons. They are carefully lagged and can be used either to supplement a hot water installation burning coal or smokeless fuel or as the sole source of the hot water supply.

The $1\frac{1}{2}$ and 3 gallons self-contained heaters are fitted on to a wall bracket and are usually cylindrical, as this offers a smaller outside surface, so avoiding heat loss. The outer case of steel is usually covered with white enamel, and the space between it and the outer case is packed with cork or some heat-insulating material. The water is contained in a copper holder. The element, suitably insulated, is fixed vertically in the container. The heater is attached to the main water pipe of the house and an inlet provided at the bottom of the container. A thermostat is included in the container.

The outlet is from an open spout above the kitchen sink, with an adjustable swivel movement. Similar heaters for larger quantities of water are placed where convenient. All water heaters must be efficiently earthed. (See Chapter 8.)

When electric heaters are required to serve several water taps, both upstairs and downstairs, the supply of the water to the cylinder must be from a cistern controlled by a ball valve. A vent pipe is fitted to discharge over the cistern if the water should become overheated if there is no thermostat or should it fail. The taps for upstairs are connected to this pipe; the outlet from the bottom of the heater will serve the downstairs taps. If the distance between the taps is great and long lengths of pipe are necessary, there will be considerable loss of heat, and it is then more economical to instal two heaters, one on each floor. The use of the existing hot water cylinder in conjunction with the domestic or coal fire boiler has much to recommend it, as the consumption of electricity will vary according to the seasons.

Water heaters of the electric self-contained type are particularly useful where there is a constant demand for hot water for washing up, as in canteens and cafés, and, since they are connected to the mains, which means that the water has not been stored in a cistern, the hot water can be used for cooking purposes or, if it is arranged to issue boiling, for making tea and coffee.

(3) *Geysers.* This method does not rely on storage of hot water, but on heating the water as it passes through the apparatus. A small cylinder, not connected with the usual hot-water boiler and cylinder, but connected with the water from the main or from the cold-water cistern, is placed directly over a sink or bath.

The fuel is gas and a small pilot light is always burning, on turning on the geyser, this lights a larger and very hot flame. The small pipe which carries the water into the sink or bath passes through the flame in a spiral, and the water is quickly raised to a high temperature. The modern gas geyser is carefully devised to minimise risk from carbon dioxide or carbon monoxide, but if the geyser is old or defective this danger may arise, and people are advised not to take a bath in a small bathroom where a gas geyser is installed without the window being open or there being an adequate ventilating system.

Temperature and Heat Measurement

Exact measurement of temperature is essential in many branches of scientific work; temperature is exactly measured by the thermometer. Simple thermometers can be made by enclosing a liquid, such as coloured alcohol or, preferably, mercury, in a bulb to which is attached a slender glass tube (from which air has been removed) carrying a scale of degrees. When heated, the liquid expands and is forced up the tube; when cooled, it contracts and falls. The exact temperature can be read against the scale. Mercury is the usual liquid used, because it is opaque and can be readily seen, can register a wide range of temperature and expands rapidly and evenly, but coloured alcohol is commonly used in room thermometers.

Special thermometers are also used for sick rooms, for baths, for cooking stoves, sugar boiling and food-preservation.

There are two types of thermometer scales in common use: (*a*) The Fahrenheit scale, where 212° is the temperature of

boiling water and 32° the freezing-point. This scale is named after its inventor and is most commonly used in this country, especially for domestic uses. (*b*) The Centigrade thermometer is most commonly used on the Continent; it is based on the metric system. In this the boiling-point of water is fixed as 100° and freezing-point is placed at 0°. In this country this scale is used for scientific purposes, but not medically, in taking the temperature of the human body.

Thermometers which are required to register constant changes of temperature, such as those used for meteorological purposes, or in taking the temperature of a room, must permit of the level of mercury fluctuating in the bore of the stem, but in the clinical thermometer used in taking the temperature of the body, the mercury level must remain constant when the thermometer is removed for examination. For this reason, the bore is so narrowed just above the bulb that the mercury, having passed through it in ascending, cannot flow down again owing to a break in the thread. It, therefore, remains constant and must be shaken down before the thermometer is used again.

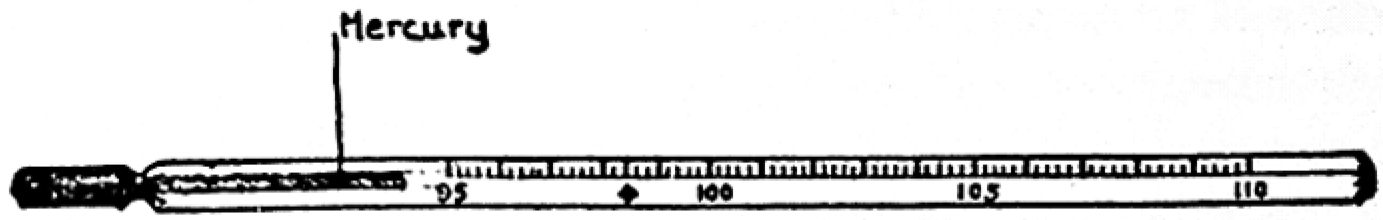


Fig. 12. A Clinical Thermometer. The arrow indicates the normal temperature of the body, 98·4° Fahrenheit.

The degrees marked on the clinical thermometer are from 95° F. to 110° F., this being the range to which it may be exposed and, for accuracy of reading, the degrees are divided up into fifths, in order that the decimal of a degree may be read, for each small deviation from the normal temperature of 98·4° is of importance in serious illness. The temperature is usually taken beneath the tongue, in the armpit or in the groin. A temperature much above the normal indicates infection of bacterial origin; a sub-

normal temperature indicates shock, starvation or other conditions which interfere with normal circulation.

Heat Measurement. Temperature and heat are usually spoken of as being identical, but this is quite wrong. Heat is a form of energy, and its measurement is based on its power of raising the temperature of a given quantity of water. The unit of heat is the *calorie*, which is defined as the quantity of heat required to raise the temperature of 1 grm. of water 1° C. (Centigrade.)

Heat can, of course, be applied to other substances than water and differing substances vary in their capacity for absorbing heat. The quantity of heat required to raise the temperature of 1 grm. of any substance 1° C. is the measurement of its heat capacity or its specific heat. Heat always passes from an object at a higher temperature to one at a lower, until they reach the same temperature.

Latent Heat. When solids or liquids undergo a change of state, as, for example, when snow changes into water or when steam turns into water, a quantity of heat is either taken in or given out without the temperature being changed. Thus, when steam condenses, i.e. turns into water, heat is given out; when water boils, i.e. turns into a gas, heat is absorbed. This 'hidden' heat, is termed 'latent heat', and it may be stored or absorbed in the substance when the change is from a solid to a liquid or from a liquid to a gas, or it may be given out as above, when the change is from a gas to a liquid, or a liquid to a solid.

The latent heat of the fusion or melting of ice is 'the quantity of heat required to change 1 grm. of ice at 0° C. to water at 0° C.' The latent heat of vaporisation of water is 'the quantity of heat required to change 1 grm. of water at 100° C. to steam at 100° C.' Thus, when 1 grm. of ice at 0° C. changes to water at the same temperature, 80 calories are absorbed and therefore the latent heat of fusion of ice is said to be 80. Similarly the latent heat of vaporisation of water is 540 approx.

These facts are applied in the home when steam is made use

of for cooking food more efficiently than if it were to be placed in boiling water. That is, steam with a temperature of 212° F. has a greater heating power than water at 212° F. because as the steam condenses the latent or hidden heat is given up and helps to cook the food. The heat, in the first place, is given by the flame beneath the vessel when converting the water into steam.

8

Electricity

ELECTRICITY is a form of energy and like many other forms of energy it can be measured and controlled and used with great accuracy. In the service of man electricity is of inestimable benefit, but it should be considered as a good servant and a bad master.

ELECTRICAL UNITS AND SUPPLY

The supply of electricity may be on a large scale from the generator in the power station or a small scale from a dry battery, such as is found in the ordinary pocket flash lamp. In either case, the electricity is conducted away from its source by wires, and its passage is spoken of as its flow, in the same sense that water flows in one direction along a prepared channel. Water always flows from a higher level to a lower level, but electricity flows in a circuit—that is, from its source back to its source, or from its source back to earth. Just as water can be forced along its channel, so an electric current or impulse is forced along its circuit by pressure and this pressure is spoken of as *voltage*. Water pressure can, obviously, vary, and so also can voltage, so that the pressure of current in our houses may be 230 volts, while on the wires of a large pylon it may be 66,000 volts, 132,000 volts or even more. The rate of the current flowing through a circuit is measured in *amperes*, or *amps*. It is essential that we should know at what pressure (voltage) our current is being supplied, in order that the appliance we use may give us the result we require; it is also essential that we should know the amperage of the fittings to which the appliances are attached or we may get too great a

current passing along wires not strong enough to carry them, which would be dangerous. Various appliances use more current than others, according to the energy required to do the work.

The power of electricity used is measured in *watts*, and knowing the pressure at which current is being supplied, measured in volts, and the current, measured in amps., the wattage is their product. Thus the number of volts multiplied by the number of amps. gives number of watts, or 200 volts $\times$ 5 amps. $=$ 1,000 watts. Similarly, if the wattage is found stamped on the appliance and the voltage is known, the amperage can be found by dividing the number of watts by the number of volts, thus 1,000 $\div$ 200 $=$ 5 amps. The *kilowatt* is also a unit of energy or power: 1,000 watts $=$ 1 kilowatt or 1 Kw.

The *Kilowatt-hour* $=$ 1,000 watts in use for one hour. 1 kilowatt-hour $=$ 1 unit used per hour. Electricity is paid for by the unit and the number of watts used by an appliance can be worked out and cost of running the equipment, if the price per unit is known. Thus, if current is charged at 1*d.* per unit, a radiator of 1 kilowatt will cost 1*d.* for each hour it is switched on. An iron using 500 watts will cost $\frac{1}{2}$*d.* per hour, or it can be used for 2 hours before 1 unit is consumed, and lamps of 100 watts will cost $\frac{1}{10}$*d.* for 1 hour's use, or can be used for 10 hours before the unit is consumed.

The electrical appliance, whatever its purpose, must become a part of an electrical circuit while it is in use; this implies that it is connected to the source of power, which is ultimately the generating station, though naturally the current passes through various stages on its journey. In its simplest form, the circuit consists of the generating station, a live wire or lead leading from it carrying the current under pressure, the consuming apparatus and a return or neutral wire which carries the current back to the generating station. On the live wire is placed a switch which, when 'off', disconnects or breaks the passage along the wire, and when 'on', closes or makes

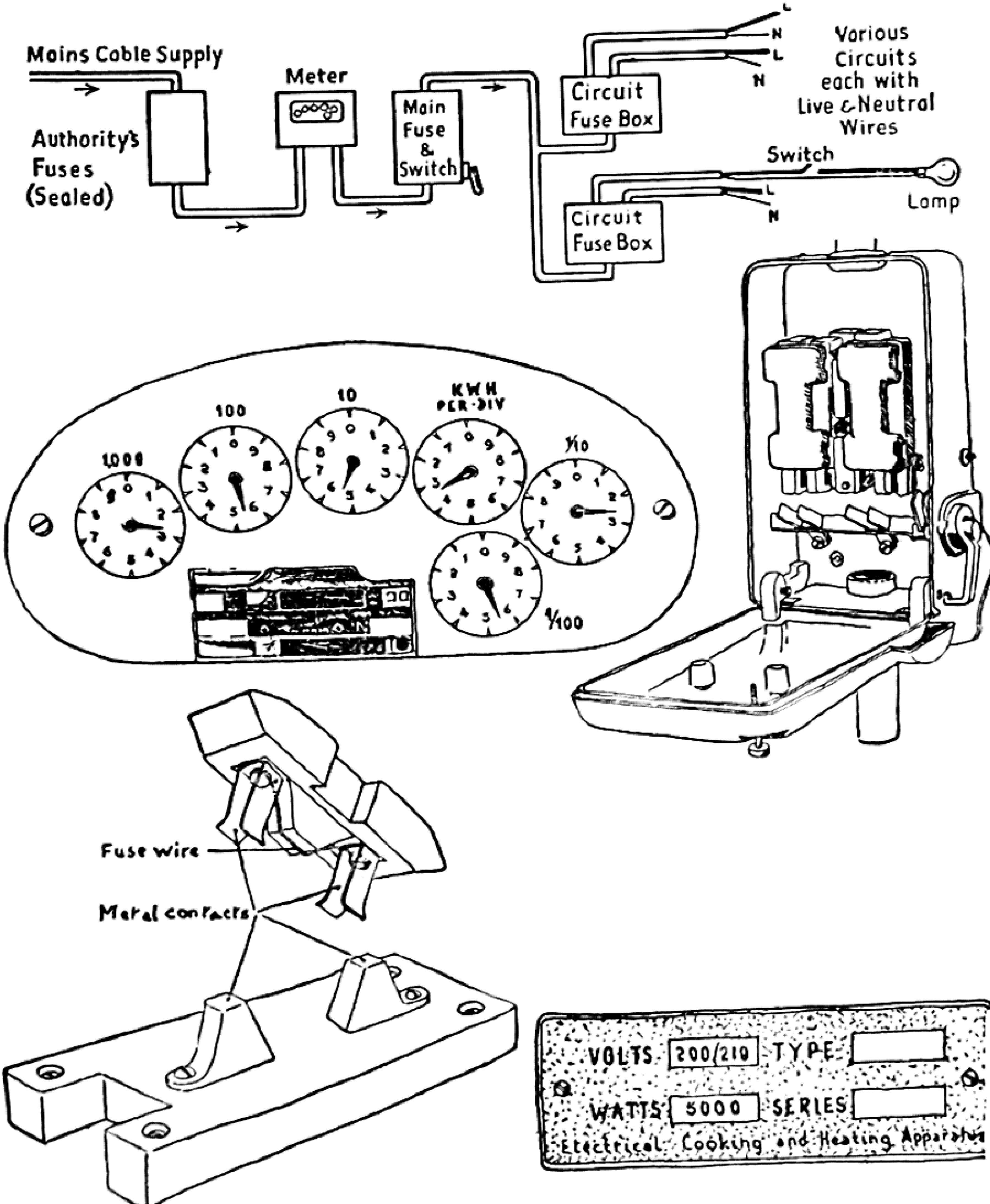


Fig. 13. ELECTRICITY IN THE HOUSE. *Top:* A simple electric house lighting circuit. *Centre left:* The dials of an electric meter. The reading is 2553 units. *Centre right:* A main switch and fuses. *Bottom left:* A simple fuse showing the fuse wire. *Bottom right:* A typical label found on electric appliances showing voltage and wattage.

the passage again. When the current flows continuously in this direction, it is spoken of as *direct current*, or D.C., and this is the method by which current is always carried from a cell or battery such as that used in portable wireless sets or to ring bells. It is more usual now for current brought from the generating station to be despatched in alternate directions along the wires, giving the name *alternating current*, or A.C., to this method. This alteration of path takes place usually 50 times in one second and the supply is said to be at 50 cycles. Therefore, the inscription '230 v. A.C. 50 cycles', informs us of the voltage and that the current is alternating at 50 cycles per second.

In most cases, apparatus may be used on either A.C. or D.C., but where it is plainly marked D.C. by the maker it may not be used with A.C. In cases of motor-driven apparatus, such as a vacuum-cleaner, hair-dryer, etc., these should not be connected with the type of current for which they are not designed, but heating, cooking and lighting appliances are free from this restriction. Many medical appliances must be worked on D.C., in which case they cannot be attached to the normal supply from the generating station.

Before the electricity is brought to the householder, shop or works, it is passed to a transformer station, where its heavy voltage is transformed to a lower level for use. It would be very dangerous and unnecessary for high voltages to be used for everyday purposes.

How Electricity is Used

Electrical energy can be made use of in the home in two ways: (*a*) to produce heat or light; (*b*) to produce movement by means of a motor. Examples of such appliances are (*a*) the cooker, electric fires and radiators, convector heaters, panel heaters, an iron, a toaster, immersion heaters, and all forms of light bulbs; and (*b*) vacuum-cleaners, washing and dish-washing machines and refrigerators. Where electricity is required to produce

heat or light, it obviously must only do so at the appropriate place in the appliance; some substances allow electricity to flow along them readily without, as it were, producing any friction or *resistance*. Such a metal is copper, for which reason the conducting wires of cables and flexibles are made of strands of tinned copper. In a heating appliance however the portion called the element is made of a metal or mixture of metals, which, while allowing the electricity to flow through it, resists its passage to such an extent that all the electrical energy is converted into heat while passing through it. Nichrome (an alloy of nickel and chromium) wire is used in the elements of of fires, cookers, irons, etc. It will be seen that the portion of any circuit from which we expect to get either heat or light must be made of a type of wire which is of a different metal and often finer than the tinned copper wire of the circuit and which is coiled, in order to increase its effective length. The finer the wire, the greater the resistance, for which reason the element in an electric bulb are much less in diameter than the stranded wire, say, in a flexible.

Ohm's Law. The pressure that forces the current along a circuit will, obviously, be affected by the resistance of a wire, since it opposes the flow, and the current will be reduced if the resistance is high.

This can be shown as:

$$\text{Number of amps. (or rate of current)} = \text{number of } \frac{\text{Volts (or pressure)}}{\text{Ohms (or resistance)}}$$

and Ohm's Law is expressed as:

'The rate of flow of electricity is directly proportional to the applied electric pressure and inversely proportional to the resistance of the circuit.'

The number of ohms is, therefore, the measure of the resistance of a wire and the *ohm* is the unit of resistance.

Resistance. A thin wire, it has been stated, has more

resistance than a thick one, also the length of the wire increases its resistance. The relation between the thickness, the length and the resistance of a wire is spoken of as the Law of Resistance, and can be stated: 'The resistance of a conductor is directly proportional to its length and inversely proportional to its cross section area.'

It is obvious that where some high-powered appliance is in use, such as a large fire or a cooker, that the amperage of electricity must be much greater than if a small-powered appliance, such as bulb or vacuum-cleaner, is in use. Where the amperage ($\frac{W}{V}$) is heavy, the wires must be correspondingly stronger and the installation capable of carrying a heavy load. For this reason, there are usually several separate *circuits* placed in a house; for example, the lighting on the ground floor on one, the lighting upstairs on another, the power for fires, etc., on a stronger circuit, and the cooker on a stronger circuit still. The lighting currents will be 5-amp. circuits, the power 15 amps. and for a large cooker it may be 30 amps. It is necessary, therefore, that an appliance requiring a 15-amp. plug socket should not be placed on a 5-amp.—for example, a 2 kw. fire should not be plugged in to a 5-amp. socket or too great a current of electricity will be called for along wiring which is not strong enough to carry it. This may have dangerous consequences, to avoid which protective devices are installed.

Protective Devices

Electricity should always be used with care and with the knowledge of its dangers. Dangers are (*a*) to the person consisting of shock and, in extreme cases, death, (b) to the appliance and to the fabric of a building in the form of fire and destruction of equipment.

Electricity always takes the shortest path to earth, which is an alternative path or 'way home', leaving its installed circuit if there is a quicker path open to it. A human body coming into

contact with a live wire offers such a path and will experience a greater or lesser electric shock according to the voltage flowing along the wire. If the live wire is in contact with, for example, the metal framework of an iron or fire and the framework is touched by the human body, the electricity will flow from the metal through the body to earth. The body will carry the flow more readily if standing in a bath, on a wet floor, in contact with a water pipe or other metal, or even if the hands or feet are damp, since impure water is a conductor of electricity. If one stands on a dry wooden floor or carpet, or if the hands are protected by rubber gloves, a shock may not be experienced, though with high voltages even these may not prevent shock. It should be remembered that the 230 volts of the domestic supply is strong enough to cause death in certain cases.

To render appliances safe in use, the following precautions are taken:

(*a*) *Insulation.* All wiring, elements, etc., are insulated. As we have seen, impure water, metals, and the human body are good conductors of electric current. The following substances are bad conductors and can be used as insulators: *Air*: the high-powered (132,000 volts) cables of the electric pylon are insulated by the surrounding air. *Porcelain* is used for suspending high tension cables from pylons, for supporting electric rails, etc. *Rubber* is used for covering electric wires and flexes. *Silk and other fabrics* are also used for the outer covering of flexes as an added protection. *Plastic* is used for switches, lamp-holders, iron handles, etc. *Wood:* the use of wood for handles and plugs has largely been supplanted by plastic. *Mica* is used for insulating elements, e.g. in an iron. *Fireclay and cement* are used for hot plates and radiators. Many of these insulating substances can be damaged, or become worn or frayed, in which case a broken live wire may cause the appliance to become alive and dangerous when switched on.

(*b*) *Earthing.* To render an appliance which is thus alive still safe, a quicker and more effective path 'to earth' than the body

is obtained by joining a wire to the metal casing of the appliance and carrying it directly to a water pipe, or to the ground outside the house. An appliance effectively earthed can be handled without the person being aware that it is defective. Large equipment, such as cookers, water heaters, etc., are fixed in one position and earthed as above. Portable appliances, such as fires and irons, which are plugged into a socket, are earthed in a different manner. In this case, the plug and the socket are earthed—that is, the socket has two terminals, one for the live wire, one for the return or neutral wire, and a third contact, from which a wire goes to earth. The plug has three pins, two short pins which come into contact with the live and neutral wire and a third and longer pin which fits into the earth socket. (See Fig. 14.) The plug is attached to a length of flex, also made up into three wires attached to the pins of the plugs. Where the flexible joins the appliance, the live wire leads to, say, the elements of a fire, one wire (the return) receives from the appliance current which makes the circuit; the third, the earth wire, is attached to the metal framework of the appliance and makes a direct path to earth via the plug socket and earth wire should the framework become alive. All appliances that are frequently handled should be earthed; electric light fittings suspended from the ceiling are not earthed so the flex leading to them is only twin or two core flex. Appliances fitted to a battery with a low voltage, such as a bell or a wireless, also do not need to be earthed. It should be remembered that where appliances are attached to the house circuit of 230 volts they are a potential danger, even if the loading of the appliance is very small in itself, such as a wireless set.

(*c*) *Fuses.* A fuse is a piece of wire of a lower melting point than the wire carrying current in cables and flexible. It is inserted in the circuit at a point near the entry into the house and provides a weak link which will melt and break if the flow of current becomes too great for safety, or if there is any fault which would raise the amperage and cause a heavier load to be

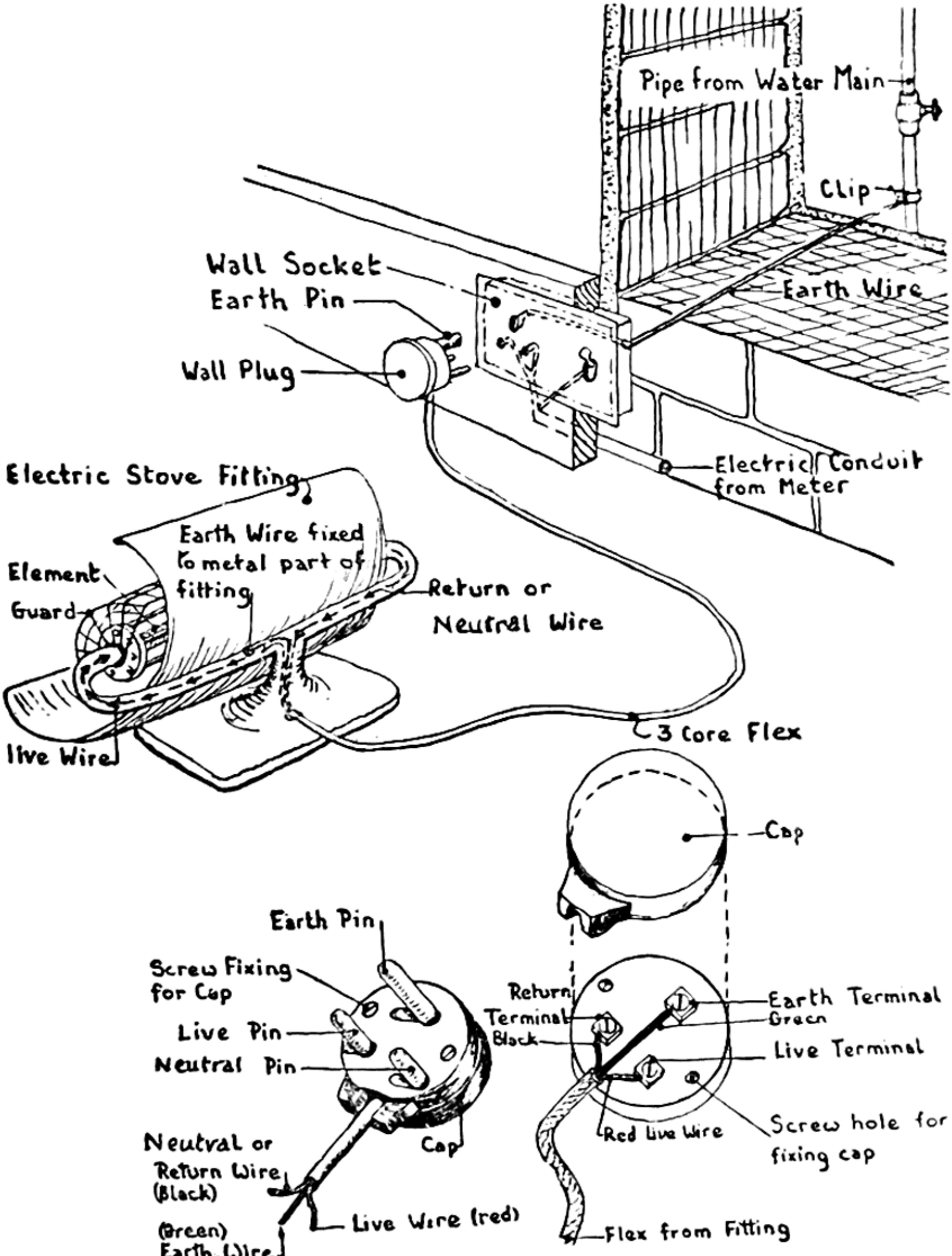


Fig. 14. HOW ELECTRICAL APPARATUS IS MADE SAFE. *Above:* An electric fire showing how a 3 pin plug is connected to the socket and how the earth wire is taken by a metal water pipe to earth. *Below:* How the wires are connected in a plug.

carried than is provided for by the house wiring. In such a case, the fuse is said to 'blow', the current fails and all equipment attached to this circuit will be inoperative. The fuse wire is made of a single strand of tinned copper wire or an alloy made of lead or tin. It must be mounted in a non-inflammable container, and fuse-carriers are made of porcelain; the carriers are mounted in a box and the whole is spoken of as a 'fusible cut-out'. (See Fig. 13.) There are often three sets of fusible cut-outs in most domestic installations: the one nearest the point of entry of the cable into the house is the property of the Electricity Authority, and is sealed and must not be touched by the householder. Another with the main switch is placed near the meter while others contain fuses for the various circuits in the house. It is possible to examine these and, if necessary, change them. Although the fuse-carriers are insulated, the main switch should be turned off when handling the fusebox. According to whether the circuit is 5 amps., 10, 15 or 30 amps., the correct size of fuse wire must be used as a replacement, for if too fine the fuse will blow again or if too thick will not be serving its purpose as a protective device. Suitable fuse wire should be kept near the fuse-boxes for use in an emergency.

Measuring Electricity

The Electric Meter. Electricity is, as we have seen, paid for by the unit or kilowatt hour. In the past there were many different ways of fixing the price of current to be charged to the consumer, but, since the nationalisation of electricity supplies, a simplified standard form of tariff, known as a 'block tariff', has been brought into use. This form of tariff is based on the number of rooms in a house, and for each room a small primary block of units is charged at a relatively high rate, for example 4½*d.* per unit, and all other units are charged at about 1*d.* In some areas, there is a small intermediate block of units for which the charge is brought down to say 1½*d.* per unit.

before the cheapest rate begins. Also, in one or two areas, consumers are offered an alternative form of charge known as a 'two-part tariff'. In these cases a lump sum is paid, based either on the floor area of the house or on the number of rooms, and then the whole of the electricity consumed is charged at a low rate, say at 1*d.* per unit. It will be seen that under this form of tariff the consumer who uses only a small amount of current, say for lighting purposes only, pays for his units at a higher average rate than the consumer who uses a large quantity of electricity for a variety of purposes, as for example for cooking, heating and other domestic purposes.

The number of units consumed are registered by a meter which is placed near the main switch and which can be easily found and read. There are different types of meters in use, but the most usual is a system of dials; the hands go round alternatively clockwise and anti-clockwise, each dial goes one-tenth of the speed of its neighbour on the right. The dials are read from left to right; the first represents 1000s, the second dial 100s, the third dial 10s, the last dial single units (the smallest dial of $\frac{1}{10}$ is usually not read.) Where the pointer lies between two figures, the lower figure is always taken. (See Fig. 13.) Everyone should learn how to read the meter to check the amount of electricity that is being used and to note any unusual or extravagant consumption.

Automatic Control. We have seen that as a means of regulating the use of electricity without the constant watchfulness that would be needed for appliances in constant use, a system of automatic control has been devised, and a thermostat is placed on water-heaters and usually cookers, central heating appliances, irons, etc., for this purpose. To use a water-heater as an example, the desired temperature of the water is decided on and the thermostat set at this point. The water is heated by the element contained in the immersion heater and the current is automatically switched off when the water reaches the desired temperature. When the temperature of the water

sinks, the circuit is automatically 'made' again and the heating of the water continues. This automatic break can be brought about in several ways. For water-heating, the thermostat consists of two metallic tubes placed, one inside the other, in the water governing the switch. The two tubes are made of different metals which have different rates of expansion when heated. As the water becomes hot, the two tubes expand, but not at the same rate, and the slight difference in movement controls the switch contacts.

Other types of thermostats are either based on a difference in expansion of metal strips which operate in making and breaking the circuit as described, or are of the vapour-tension type. In this case, a small phial containing a volatile liquid is fixed, for example, in an oven; the phial is connected by a capilliary tube to a flexible bellows, and when the whole is heated, the liquid vaporises and stretches or expands the bellows. This mechanism acts on the switch and separates the contacts and breaks the circuit. As the oven cools down, the vapour once more becomes a liquid, the bellows decrease in length and the switch is no longer depressed, so that contact is made once more.

Alternating current cannot be stored and is generated as it is used. For this reason, there are certain periods of the day when the power stations are producing less electricity, particularly during the night. This 'night current' can generally be obtained at a reduced rate and can be used for heating water or rooms by resistance wires buried in the floor.

With the coming of atomic energy it is clear that greater use will be made of electricity in the future for heating the home and for labour-saving generally.

9
Gas

COAL gas is produced from coal. The coal is heated in retorts without air. An inflammable gas is given off by a process of destructive distillation; after purification, it is collected and stored in gasholders and distributed by means of pipes or gas mains to houses, streets and factories. Where the pipe enters the building is a meter which registers the amount consumed in therms; a main gas tap is always placed at the point of entry, and it is possible to turn this off, for safety's sake, when there is an escape of gas, when repairs are required, or when leaving a house unoccupied for some time. The gas is carried round the house by pipes, introduced into the walls, to the various appliances.

There are several by-products obtained when gas is produced: for example, ammonia, an alkaline substance from which nitrates can be made, or, more usually in the case of gasworks, an artificial fertiliser, ammonium sulphate; and coal tar, a sticky, dark-brown substance from which many substances, such as dyes, medicines and perfumes, are produced. These by-products are as valuable as the coal gas.

After the extraction of the coal gas and its by-products, coke, a porous substance containing pure carbon, is left. Coke is a very valuable fuel when burnt in furnaces and closed stoves; it does not burn readily in an ordinary open grate, but specially constructed basket grates may now be obtained in which coke is more easily combustible. When burnt in a properly constructed stove, an intense and glowing heat is obtained without flame or smoke and, as coke is slightly cheaper than coal, it makes a suitable fuel for centrally heating schools,

offices, hotels and other large buildings. Since coke is a smokeless fuel, smoke pollution could be eliminated if it were generally used.

Coalite is a form of coke obtained by the production of coal gas at lower temperature than ordinary coal. It is more suitable for use on the domestic grate and gives a pleasant form of heat, with some flame.

Coal gas is made up of a mixture of gases, chiefly marsh gas and hydrogen; there is also present about 10 per cent. of carbon monoxide. Other gases, such as ethylene, are present and also carbon dioxide and nitrogen. To obtain a heating flame from coal gas, a certain amount of oxygen must be present, and air is introduced into the pipe just before the gas reaches the burner, whether it be a bunsen burner or the jets of a gas stove. The size of the hole can be regulated, and with varying amounts of air the colour of the flame will also vary; a blue flame is required for heating; if, however, it is tinged with yellow, combustion is imperfect and more air—or oxygen—is required. Such a flame deposits soot, but in a properly adjusted faint blue flame combustion is complete. Fuel of any type burning in a room produces carbon dioxide and since gas fires and gas jets also use some oxygen rooms containing them should be adequately ventilated.

Coal gas has two dangers in the household:

(*a*) It is a poisonous gas and, if inhaled in quantity, will cause death. Faulty fittings, leaky taps and jets are dangerous; a small jet blown out by a draught may cause the air of the room to become charged with gas and this, breathed by a sleeping person, will cause suffocation.

(*b*) A mixture of coal gas and air is explosive, and a naked light used in a gas-filled room in searching for a leak, or applied to an oven which has been shut with the gas turned on, will produce a serious explosion.

Gas Appliances. Although electricity has largely supplanted gas for lighting, gas cookers, gas fires and gas geysers have their

very definite advantages. Heat is quickly obtained from gas appliances. A gas ring, however, although ready for use when lighted, does not retain heat as does an electric solid boiling plate. Once the gas is turned off burners and ovens cease to cook almost at once. Modern gas appliances can be thermostatically controlled, and the Regulo type of cooker if correctly set ensures that foods do not burn or the temperature rise beyond a certain height.

Measurement of Gas. Gas is measured and sold to the consumer by the *therm.* The British Thermal Unit (B.Th.U.) is the amount of heat required to raise the temperature of 1 lb. of water by 1° F., and the therm is equal to 100,000 B.Th.U. The heating, or calorific, value of gas is given as the number of B.Th.U. of heat which will be produced by 1 cubic foot of gas. 1 B.Th.U. = 252 calories. (See p. 59.)

The amount used is registered by a gas meter, which gives the reading on the dials in cubic feet, not in therms, though this is estimated and stated on the gas bill by giving both the cubic feet and the therms they represent. The dials are worked by levers and spindles brought into operation by the gas passing through a bellows device. The dials are read from left to right, the lower number always being taken if the hands are in a position between two figures. The first figure is hundreds of thousands, the second tens of thousands, etc.

Strict economy and careful handling are most necessary if gas is to be used to complete advantage in the home, and the quick control of the gas tap on most appliances is one of the points in its favour.

10

Lighting

THE lighting of homes can be divided into (*a*) natural lighting, (*b*) artificial lighting or illumination.

Natural Lighting

The sun's rays during the daytime are very penetrating, as will be realised when trying to darken a room for photographic purposes. The intensity of the light depends on whether there is sunshine or cloud, or whether there is a pall of smoke in the atmosphere. The amount of light available inside will depend on the aspect of the house, the size and type of windows and the amount of screening or curtaining applied to them. The most sunny aspect is south, in both winter and summer, while the longest light is in the north in summer and in the south in winter. Clear glass windows will obviously allow light to penetrate better than clouded, frosted or even dirty glass. To obscure windows by heavy layers of curtains is usually unnecessary and unhygienic. Sunlight can be divided into the colours of the visible spectrum, and beyond the visible range are the infra-red rays and the ultra-violet rays. The ultra-violet rays are health-giving and affect the fat layers beneath the skin, forming vitamin D in the body. These rays cannot penetrate readily through smoke or through glass, for which reason sunshine enjoyed behind the glass barriers of windows cannot take the place of sunshine experienced in the fresh air. Vita glass can be used, which allows the passage of the ultra-violet rays, but its price is much greater than ordinary glass, and up to the present its use has been strictly limited.

Red rays are felt by the body as heat. They can penetrate glass, and when they fall on the object some are absorbed and the temperature of the object rises. Rays are radiated by the heated object and these are unable to pass through the glass again, and so the temperature of the room rises. Thus, on a sunny day, the temperature of a greenhouse rises considerably.

The necessity for fresh air and sunshine for bodily health cannot be overestimated, and bright and sunlit rooms cannot be considered as a substitute, unless it is possible to throw open the windows wide and for the inmates actually to feel the sunshine on the skin, without an intervening layer of glass.

Artificial Illumination

The following are the accepted methods of lighting rooms:

(1) *Candles.* These are made by coating a central wick of cotton material with layers of tallow or wax. When the wick is lighted, a flame is produced by the combustion of the carbon in the wax with the oxygen in the air. The wax is first melted and travels up the wick; it is here vapourised and burns in flame. This flame will be seen to have distinct areas or zones, in which the illumination is of a different degree or quality. The inner dark zone consists of unburnt gas, the middle area or zone is yellow and most luminous, consisting of carbon particles which are incandescent, while an outer area, less noticeable, is where combusion is complete and heat, rather than light, is produced. This is also the case at the base of the flame which is pale blue in colour. A gas flame from a bunsen burner with air holes closed, or from a jet, is of the same nature and shows the same difference in illuminating properties in the various zones. It is possible to insert in the inner zone a small tube and to ignite the unburnt gas which passes up it. The soot from a flame which is deposited on, for example, a pan is the result of carbon particles incompletely burnt in the incandescent zone. A gas flame from a bunsen burner where

the air hole is properly adjusted should show no luminous zone.

Although candles are now seldom used as the main source of light, candle power is still used as the standard of artificial lighting, as horse power is used as a standard of mechanical power. It is based on the amount of light given out by a standard candle. The foot-candle is the unit of measurement of the intensity of illumination. One foot candle is the intensity of illumination of a surface which is at all points one foot away from a standard candle. The wax candle is now superseded for measuring foot-candles by a standard electric bulb, which has ten times the power of one standard candle.

(2) *Oil Lamps*. The original antique oil lamps burning animal or vegetable oil were of the same principle as a candle with the wick floating in the oil; the modern lamp burning paraffin oil (which is a mineral oil) has an adjustable wick and produces the same type of flame. The illumination is usually intensified by the use of a glass globe or a reflecting surface. The light from a large lamp can be both pleasant and mellow, and restful to the eyes, but its illuminating powers are small compared to more modern methods of lighting. To obtain good results, the lamp must be filled daily, and must be kept clean to prevent a smell of paraffin, and the wick should be well trimmed and quite even, or the glass chimney will be smoked. In fact oil lamps demand constant attention. Incandescent burners are fitted on some types of lamps, and these give a far stronger and whiter light.

(3) *Gaslight*. Gas light was introduced in this country about 1820. When used for illuminating purposes, the flame should be yellow; when for heating purposes, blue. The gas burns with a blue flame when air is mixed with the gas at the point of exit to the burner, as in a bunsen burner or gas jet on a stove. A yellow, unshielded light is not, however, by modern standards a very good illuminant, and it was only on the introduction of an incandescent mantle, made of a chemical fabric,

which is placed over the flame and which produces a very bright, almost white, glow that gaslight became, in the late nineteenth century, almost universal.)

(4) *Electric Lighting.* (The use of electricity for lighting in homes, factories, shops, etc., has almost entirely superseded the use of other illuminants. The advantages are (*a*) that it is efficient and adaptable, (*b*) it is clean, produces no fumes or carbon dioxide and uses no oxygen from the air of a room, (*c*) it can be regulated in intensity, according to the power of the bulbs used, (*d*) it is comparatively inexpensive, especially if other electric appliances are to be used in the house and the cheaper rate of payment is available (i.e. the 'all-in' tariff). The electric current flows along the cables and wires, which connect to a ceiling rose or to a socket in the wainscot made of porcelain or bakelite, and through twin flexible wires to the lampholder; this also is usually made of bakelite or some non-conducting material. The electric bulb is fitted into the lamp-holder, making contact with the two spring terminals attached to the end of the wires.)

The electric bulb is made of glass; this may be clear or opal or pearl (the advantages of these types will be discussed later). The bulb is filled with an inert gas, argon or nitrogen and is known as the gas-filled bulb; earlier types of bulbs contained a vacuum and were known as vacuum bulbs, but the gas-filled type gives better illumination and has a longer life. The electric current flows through a fine filament made of tungsten; this substance offers a resistance to the passage of electricity. The passage of the current through the filament produces a brilliant glow and a certain amount of heat. The higher the wattage of the lamp the brighter will be the light. For small lights in cupboards, etc., the wattage may be as low as from 15 to 25; 40 watts may be used for bedlights, etc., but the normal medium light for rooms is from a bulb of 60 watts at least. (This power may be used in bedrooms, in small kitchenettes, pantries, etc., and also in a central fitting which contains

two or three bulbs, or in a standard lamp or wall lamp. For a good light for reading, writing, and sewing and to give a cheerful amount of illumination in the living-room, 100-watt bulbs are most commonly recommended, though, obviously, to have several points in a room connected with bulbs of lower wattage, which can be used according to need, is often both more efficient and economical. Kitchens and workrooms are frequently ill-lit, and this may be a cause of accidents and of strain to eyes and nerves.)

Discharge Lamps. Electric discharge lamps have been in use for some time for street lighting, and tubes filled with neon gas, giving a red glow, are used for signs and for advertising purposes. The illumination is obtained by applying a current at high voltage to 'electrodes' placed at each end of a tube containing gas. A bright glow or light is set up in the gas, giving the well-known red, orange and pale blue, depending on the gas used.

Fluorescent lighting is based on the same principle, the passage of electrons through a gas, and tubes for fluorescent lighting are available for domestic purposes. In these tubes, however, the gas, mercury vapour, is at a low pressure and little light is emitted from the gas itself when current is passed. The chief source of light is due to a coating of powder on the inner surface of the tube; this powder glows when the *invisible* ultra-violet rays produced by the discharge fall on it. It is the fluorescent glow which produces the light, and various powders produce various colours.

The mercury vapour in the glass tube is at a low pressure, and the electrodes are of tungsten, coated with a substance which will emit electrons. When the electric current is switched on, a 'choke' inserted in the circuit produces a change in the flow of current, setting up a temporary high pressure in the choke, this having the effect of heating the electrodes. When once the electrodes have been heated, the light will be produced by the ordinary voltage from the mains.

In addition to the intense light given by a fluorescent lamp, other advantages are that a 60-watt loading is sufficient to produce a brightness which could only be produced by 150–200 watts in an ordinary bulb, and that the tubing has a longer life than the ordinary bulb. If, however, the fluorescent tubing is continually switched on and off, its length of life may be shortened, and this method is not suitable where the light is only needed for short periods of time. Fluorescent tubes can be trying to the eyes if placed at the wrong level, but they are most frequently placed at ceiling height, and are sometimes shaded to avoid glare.

Points to be Observed in Good Lighting

There are certain points to be considered in good lighting which apply equally to all forms of illumination, but, since electricity is now the most usual method, they will be taken from the point of view of the use of the electric bulb. Illumination can be arranged in the following ways. (See Fig. 15.)

(*a*) *Direct Lighting*. By this method the bulb is covered with a shade which, though generally translucent, yet deflects the light downwards in direct rays. This is suitable for close work in offices and factories, as the light is thrown on to the work beneath. If the light is at eye level, great care must be taken that the filament is not visible, as the bright light produces glare which strains the eyes, causes irritation and restlessness, and is bad for the nervous system; also, such lamps and fittings frequently cast a shadow which, when it falls on work, is both annoying and a strain. For this reason, the clear glass bulb should not be used in direct lighting; the pearl or opal bulb should take its place. These produce a mellower, softer light. A very small percentage of light is lost in such bulbs, but in direct lighting this may be considered as negligible.

(*b*) *General and Semi-indirect Lighting*. The latter method is most commonly used in the lighting of living-rooms. The

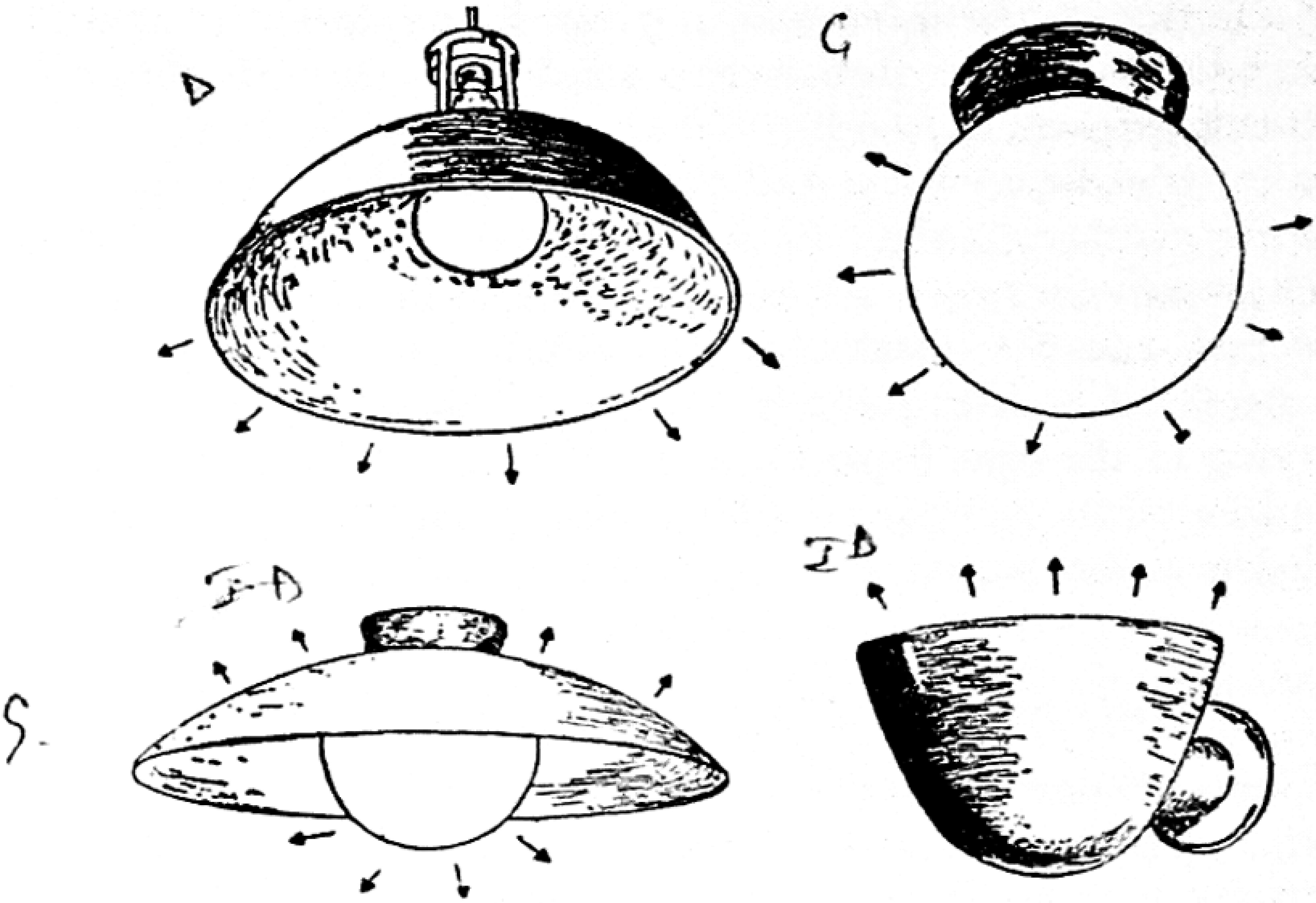


Fig. 15. VARIOUS FORMS OF LIGHTING. *Top:* Direct and general. *Bottom:* Semi-indirect and indirect.

bulb is contained in an inverted bowl or similar fitting, most of the light being directed upwards towards the ceiling, from whence it is reflected downward, but, since the bowl is transparent, an almost equal quantity of light is transmitted downwards. As the bulb is concealed, one of clear glass should be used to obtain the maximum of light. In general lighting the clear bulb is placed in a totally enclosed translucent fitting which gives equal lighting in every direction.

(*c*) *Indirect Lighting.* The indirect lighting is used most commonly in shops, churches, halls and large rooms. The source of the light is concealed and the illumination is usually deflected upwards or sideways on to a ceiling or wall. In this case, again, a clear bulb should be used in the fitting.

The degree of illumination in a room depends, to some extent on the surface on which the light falls. Coloured

surfaces absorb light in varying degrees. White and cream are not absorbent, black, navy, dark brown, grey, and red are most absorbent, and it is unusual for these colours to be used in modern room decoration and furnishings.

Glare is to be avoided in all methods of lighting. As stated, this may be brought about by the use of clear bulbs in direct lighting, also by insufficiently shaded lights and by reflected glare, this being particularly harmful to the eyes if from polished surfaces.

Shadows are irritating if thrown on close work, and can be confusing and dangerous in certain positions. Badly placed lighting points and the wrong type of fittings are usually responsible. General, indirect and semi-indirect methods of lighting do away with heavy shadows.

Maintenance. Electric light bulbs and fittings require cleaning at regular intervals, as efficiency is lost when they are stained and dusty. The average life of a bulb is 1,000 hours, and when it begins to lose its brightness the value of the electric current being used and paid for is partially lost.

II

Foodstuffs

FOOD is required (*a*) to produce heat and energy, (*b*) to build and replace tissues, muscles and bones, (*c*) to provide mineral substances required by the blood and the glands, and (*d*) to protect the body from disease.

The majority of foodstuffs are complete substances fulfilling several, if not all, of these functions, but in the case of many foods, such as milk or bread, each of their component parts can be allotted to one or other of the above categories.

The types of foodstuffs are:

HEAT- AND ENERGY-PRODUCING FOODS

(1) *Carbohydrates*, which contain carbon and also hydrogen and oxygen in the same proportions as in water. Starch, sugar and cellulose are examples of carbohydrates; they are obtained from vegetable sources, although there is sugar in milk and glycogen, a form of animal starch, in liver.

Starch is found in the form of minute grains in the cereals wheat, maize, barley, oats, rye and rice, and in root vegetables, particularly potatoes. The grains differ in size and shape, according to the plant from which they are obtained. Pure starch is found in cornflour extracted from maize, and in arrowroot, but the natural foodstuffs containing much starch, such as potatoes, wheat and rice, also contain substances which give them a value in addition to that of producing heat and energy. *Sugar* is found in root vegetables, such as beetroots and carrots, in ripe fruits, in the sugar cane, and in honey. Crystallised sugar, as we buy it, must pass through many processes of manu-

facture and is a pure carbohydrate, but natural sugars in vegetables and in fresh and dried fruits are combined with other food substances which enhance the dietetic value of the sugar obtained from these foods. *Cellulose* is present in the walls of the cells which make up the entire structure of a plant. In itself, cellulose is not digestible, and cannot therefore be strictly called a food, but it is necessary to successful digestion, the digestive organs requiring a certain amount of bulk on which to exercise themselves. Too refined a carbohydrate diet is not advisable. This cellulose bulk is spoken of as 'roughage'.

(2) *Fats and Oils* are made up of carbon, oxygen and hydrogen, the latter two not in the same proportion as in water. Fats are composed of fatty acids and glycerine, the acids varying according to the source of the fat. The fats are split up into their two parts during the process of digestion. Some of the acids are less valuable than others, and some have an irritating effect upon the digestive organs of those who are allergic to them.

Fats are obtained from many animal sources: from milk, cream, butter, cheese, meat fat, liver, eggs and from fish. There are also a large number of vegetable oils used for foods; olive oil, palm oil, ground-nut oil, etc.

The fats from animal sources are more valuable than those from vegetable, as they contain vitamin A, while many, particularly those from milk, liver and eggs, contain vitamin D as well. The shortage of these vitamins will lead to most serious deficiency diseases. Vegetable oils do not contain vitamins, and they are considered inferior in value. The food value of margarine, as at present manufactured from vegetable oils, is increased by the inclusion of vitamins A and D during its manufacture. The calorific or fuel value of fat is greater than that of any other foodstuff; a given weight of fat will produce twice the heat that the same amount of either carbohydrates or proteins do. This renders fat a most important food to those living in cold climates, or in the winter-time. Also, since fat is

finally absorbed several hours after it has been eaten, it is a satisfying and lasting food, though for the quick relief of hunger and immediate results, sugar will serve the purpose better.

Building Foods

Proteins are complex substances containing, in addition to the carbon, hydrogen and oxygen found in carbohydrates and fat, the element nitrogen, while some contain also phosphorus and sulphur. For this reason, they are sometimes spoken of as 'nitrogenous foods'. Since the proteins contain all the substances necessary for building protoplasm, they are termed 'body-building foods' and the elements they contain are compared to 'bricks' for building growing tissue or replacing worn tissue. Without protein in the diet, the muscular tissue would waste and the various organs of the body deteriorate. Proteins are only found in appreciable quantities in a limited number of foods, and these are often unobtainable in large quantities and are expensive. Protein deficiency is common in any poor and backward community, or among those who are restricted to a vegetable diet. Proteins, during digestion, are broken down into amino-acids before they can be absorbed into the blood stream. There are, roughly, twenty different amino-acids which are necessary for building the body; with the exception of milk, the amino-acids are not derived from any one food, but the largest range is found in animal foods. These animal proteins are known as *first-class proteins*, and include those present in milk, cheese, meat, eggs and fish. The *second-class proteins* are obtained from vegetable sources, chiefly from the seeds of plants: for example, all the cereals, wheat, barley, oats, rye and rice; the pulse foods, peas, beans and lentils; and the various nuts used for foods. A well-regulated mixed diet containing a variety of proteins from both animal and vegetable sources is considered by most authorities to be the best.

PROTECTIVE FOODS

In this group are included (*i*) mineral salts and (*ii*) vitamins. They are so called because their inclusion in the diet protects the body from various deficiency diseases and supplies the blood stream, the glands, teeth, bones and nervous system with essential substances without which their functions cannot be carried out.

(i) *The Mineral salts.* The most important of these are:

Calcium salts, which are deposited in the cartilage of growing bones and turn them from firm but pliable gristle to the rock-like structure of the adult bone. Calcium is also required for the formation of strong teeth. It is found in milk, eggs, green vegetables and nuts.

Iron Salts. Iron is required to form a part of the hæmoglobin of the red corpuscles in the blood. Hæmoglobin carries oxygen from the lungs to the tissues and if iron is deficient the body will be anæmic since it will not be able to obtain an adequate quantity of oxygen. Iron salts are obtained from red meat, eggs, milk, spinach and other green vegetables and pulses.

Iodine in the form of iodides is an essential substance for the proper working of the thyroid gland. It is found in fish and all marine foods, and if seaweed is used as a fertiliser in the ground, foodstuffs grown there will contain this valuable substance.

Phosphorus goes to form the brain and nervous tissue and is essential to growth of bone. It is found in fish, egg yolk, liver and the germ of wheat.

Sulphur is essential for producing protoplasm; it enters into the composition of the blood and helps to form the skin, hair and nails. Sulphur is obtained from egg yolk, pulse foods and some green vegetables.

Sodium chloride, or common salt, is required for all the fluids of the body and, in particular, in the blood stream. Without a continuous supply of sodium chloride, life cannot be supported,

and a vegetarian diet demands that salt should be added to it.

(ii) *The Vitamins* are spoken of as accessory food factors and are present in minute quantities in many foodstuffs. Their function is to promote growth and development, particularly in the bones and teeth and glands, but their effects are far-reaching on all parts of the body. They protect the body from disease and are necessary for its proper functioning. Their absence will account for a variety of deficiency diseases. It is in cases of starvation or malnutrition due to famines and wars that the effect of vitamin deficiency is seen in its most terrible aspects, but vitamins can be lacking in the diet of many people who are merely making a bad choice of foods and diet. Medical science has so far advanced that deficiency diseases are readily detected and treated, though prevention of disease is always preferable to curing it.

The vitamins have been listed alphabetically, A, B, C, D, and E, and progressively through the alphabet as new knowledge develops, but actually the divisions and sub-divisions of the Vitamin B complex have accounted for many of the new vitamins.

Vitamins can be dissolved in either water or fat, the fat-soluble vitamins being A, D and E, while those soluble in water are vitamin C and the vitamin B complex. Vitamin A and D are found, with some exceptions, in identical food-stuffs, and originally were considered as one. They are, however, different substances having different effects on the body.

Vitamin A is known as the anti-infective vitamin; it prevents complaints of the chest, nasal passages and respiratory disease in general. It also has a marked effect on the eyes, and improves night vision. This vitamin is found in fish-liver oil, which for many years has been known as a remedy for pulmonary diseases. It can be found in carotene in carrots, and is present in milk fats, liver and green vegetables.

Vitamin D is the anti-rachitic vitamin which prevents rickets,

a deficiency disease affecting the bones, teeth and other tissues. Since the bones of infants are made of cartilage, a strong gristle, it is necessary that calcium salts from food should be gradually absorbed into them to produce the hard substance we know as bone. If bones do not harden, in due course, when the child begins to stand and to walk, those of the legs will bend outwards or inwards. Rickets, however, affects not only the leg bones, but any of those making up the skeleton, and the ill health and deformity that rickets produces can be very serious.

The calcium salts are obtained by the infant from milk, and the importance of an adequate amount of milk of a good quality for feeding infants is obvious.

Vitamin D is sometimes spoken of as the 'sunshine' vitamin, since it can be formed in the body by the rays of the sun acting on the fat layers beneath the skin. Ultra-violet ray treatment or exposure to sunshine is used in the treatment of rickets in addition to the cod-liver oil treatment. Vitamin D is found in cod- and halibut-liver oil, in liver, in cream and butter, especially from summer milk. In the case of the fish oils, the fish feed on plankton in the surface layers of the sea and store the vitamins in the liver. Dairy produce is richest in the vitamin when the cows have fed on grass exposed to summer sunshine. Egg yolk is also rich in vitamin D.

Vitamin C is the anti-scorbutic vitamin, preventing the disease of scurvy, which affects the skin, gums and nervous tissue. The vitamin is found in the form of ascorbic acid in many fresh fruits and vegetables. Scurvy has long been known to follow a diet of dried and salted foods, such as was common at sea in the days of sailing vessels. It was found that if potatoes, lemons or limejuice were given, scurvy could be prevented. The use of orange juice in addition to cod-liver oil for infants has now become so general that scurvy and rickets are rare among children in this country.

Vitamin C is to be found in the citrus fruits, oranges, lemons

and limes: in blackcurrants, rose hips and tomatoes; also in most of the green vegetables, such as spinach, watercress, cabbage, etc. A smaller quantity is present in potatoes, and the amount in milk varies according to the season, hence the addition of orange juice to the diet of the bottle-fed infant. This vitamin is the most unstable of the vitamins, and it is quickly destroyed by preservation, particularly where air is present; by keeping food until it is stale, by over-cooking and by re-heating; by the use of alkaline substances, such as soda when cooking green vegetables; by chopping or mincing the food, and by exposing milk in bottles to sunlight.

Vitamin B Complex. The various components of the vitamin B complex are water-soluble. They are essential for the digestion and absorption of carbohydrates and also of proteins. The lack of these vitamins leads to obscure nervous and digestive disease, such as beri-beri, pellagra, dermatitis; these diseases are to be found in states of extreme malnutrition or in communities living in poverty-stricken conditions. In this country, lack of tone of the digestive and nervous systems may be traced to lack of one or other of the substances classed as Vitamin B. Vitamin B consists of six components, of which Vitamin B_1 is the most important, together with the substance aneurin hydrochloride, which is found chiefly in whole cereals which have not had the husk or outer layers removed, such as unpolished rice, and in wheat germ, etc. Also, it is found in liver, eggs, nuts and yeast, together with vitamin B_2, which is called riboflavin. The latter is found in milk, yeast, liver, wheat germ, eggs and green vegetables.

Dietetics

In order to obtain a well-balanced diet, our foods must be correctly combined to give us sufficient heat and energy; all the foods we digest can be used for this purpose, but it is usual to choose, almost unconsciously, the fats, sugars and starches which produce energy most efficiently, and to take our proteins

in smaller quantities, merely for body-building purposes. It can be estimated scientifically exactly how much heat any given weight of foodstuff will produce and the unit chosen is the *great calorie*. A calorie is the amount of heat required to raise 1 grm. of water 1° C., and a great calorie is a thousand times this amount. Food tables have been produced giving the calorific value of all the common foods in ounces or pounds.

It will be found from these estimates that—

1 oz. of carbohydrate	=116	great cals.
1 oz. of protein	=116	do.
1 oz. of fat	=263	do.

If, therefore, energy value was the only result required from foods the use of fat alone would seem the answer to our dietetic problems but, in the chemistry of the body, carbohydrates are essential to help the combustion of fats and a very delicate balance between the intake of carbohydrates and fats is essential. Roughly, four times as much carbohydrate as fat in the daily diet is necessary to maintain this balance.

The number of calories required by a person depends on the energy he gives out in the form of movement or work and, after much experiment, it has been decided that the average number of calories required by a man doing light work is 3,000 daily. The harder the work, the greater the intake of food must be, so that a coal-miner or agricultural worker may require as many as 4,500 to 5,000 calories per day. A woman requires slightly less food than a man, and adolescent boys and girls will require as much food as their parents.

It is possible, with the aid of food tables, to calculate the exact number of calories produced by each food we eat and, after allowing for wastage in preparation and cooking, the calorific value of our meals can be found. It is rarely that such a calculation will be made for the ordinary household, but in large-scale catering in schools, hospitals and camps and in

dietetic kitchens the calorific value of meals should be frequently checked.

The energy value of food, however, is only a part of our dietetic needs. An adequate amount of protein, roughly half of our diet, is necessary and the protective foods are essential for good health.

For normal healthy people, working hard and taking reasonable exercise, with no particular fads and fancies, appetite is a useful though unscientific guide to the quantity of food required; but it is obvious that the food provided must be of the right type, and for this to be achieved some knowledge of food values is required by the housewife. A diet of potatoes, bread, margarine and tea, though adequate in bulk, would obviously be deficient in proteins and protective substances.

The following should be included in the daily diet: milk, green vegetables and fruit, wholemeal and whole cereals, e.g. brown bread and oatmeal, some animal fat of first class value, e.g. butter, cream, fish oil, some animal protein of first-class value, particularly liver, eggs, cheese or fish. The foods which give the best value for the money expended are such vegetables as carrots, spinach, tomatoes; fruits, such as oranges and blackcurrants; oily fish, such as herrings; or nuts, liver, and milk.

12

Cooking of Food

THOUGH many foods, particularly those containing Vitamin C, are better served uncooked, foods are cooked (*a*) to soften and make possible the digesting of starch, fibres of meat, etc., (*b*) to kill harmful bacteria. (*c*) to combine flavours and make food more palatable, (*d*) to give a variety to the diet.

THE EFFECTS OF HEAT ON FOODSTUFFS

Cooking is the application of heat to various foodstuffs which, in some cases, brings about a change in their nature. Heat so applied can be in the form of (*a*) dry heat, such as in baking, grilling; (*b*) moist heat in the form of water or steam, such as in stewing, boiling, steaming; (*c*) hot fat, as in frying.

The Effect of Moist Heat upon Starch. Starch is found in the form of small grains, their shape and size varying according to the plant from which the starch is obtained. When the starch grains are soaked in a liquid, the membrane round the grain becomes softened and the grains swell considerably. As the water is heated, this swelling of the grain continues until, at boiling point, the membrane is ruptured, the starch comes out and thickens the liquid. Starch, in the form of cornflour, flour, sago, etc., is added to liquids to make a thickened sauce or to make a more solid substance, such as a blancmange or mould.

If the starch grains are allowed to settle at the bottom of the vessel before the liquid has reached boiling-point, the grains will cling together and lumps will be formed. Careful stirring, therefore, is necessary; the movement also assists in the

breaking down of the membrane. If boiling water is poured on dry starch, the outer starch grains will be cooked, but the inner grains will remain uncooked and, again, a lumpy mixture will result. If the cooking process is incomplete, some of the grains will not be properly softened and a somewhat gritty mixture will be the result.

Effect of Dry Heat. If starch is heated by dry heat—for example, on an oven shelf or in a dry pan—it will first turn a pale cream, then gradually become darker until it attains a cocoa colour, and will eventually burn, leaving a mass of charcoal and then ash. During this process water will be given off and the starch is changed into dextrin, a form of sugar. Dextrin is soluble in water, whereas uncooked starch is not; also, it can readily be absorbed without the assistance of digestive juices. For this reason, dextrinated foods can be given to babies who cannot digest pure starch, and rusks, toast and crusts are found to be more digestible than, for example, the white crumb of a loaf.

Effect of Moist Heat upon Sugar. Sugar is soluble in water, warm or hot water being more solvent than cold. When the solution attains saturation point, no further sugar will dissolve. When sugar and water are boiled for some time, the water will evaporate and the sugar and water becomes a thick syrup. As the boiling proceeds, the sugar begins to turn into caramel and it will eventually burn, leaving first a mass of carbon and then ash.

Effect of Dry Heat. Sugar will quickly turn into caramel when dry heat is applied, and will soon burn.

Effect of Moist Heat on Proteins. Many of the proteins, particularly the albumin found in meat, fish and eggs, are soluble in water and they can be extracted by soaking the foodstuffs in cold or warm water.

When heated, albumin gradually coagulates, thickening

slightly and becoming first a jelly-like mass, then a firmer substance, as exemplified by the white of the hard-boiled egg. At 185° F. the albumin becomes firm, and at boiling-point completely solid. This effect of heat has several important bearings on the cooking of food: (*a*) When it is desirable to retain the juices and flavour in meat, it is customary to subject the outside to intense heat for a few minutes to harden and seal the albumin. For example, in grilling, the placing of the food near the embers or near a hot grill prevents the loss of juices. (*b*) When food possesses no natural coating which will prevent the entry of fat during frying, the food is coated with egg, the albumin of which seals the outside and keeps the food from becoming sodden and greasy. This is necessary when cooking fish-cakes, rissoles, etc. (*c*) When egg is beaten and mixed with milk, as in making custards or for thickening soups, the albumin in the white will separate from the liquid if it is allowed to boil and will form lumps, giving the whole a curdled effect. It is necessary to stir or beat the liquid well as it is heating to prevent lumps forming.

The casein in milk or cheese does not coagulate as does albumin, but, after the evaporation of water, it becomes very hard and brittle when heated.

Gluten, the protein of wheat, also hardens when heated, giving the firm crust and crumb of the loaf and retaining the shape of the bubbles of gas forced through it by the raising agent.

The Effect of Heat on Fat. Most fats, when cold, are solids, but melt when heat is applied, and become a liquid. As the heating continues, water is driven off, giving a bubbling sound; after this stage, the fat becomes smooth and a faint blue fume is given off. This is the stage when it should be used for frying. If allowed to heat further, the fat begins to brown and burn (giving an unpleasant flavour to food cooking in it) and will, eventually, burst into flames and burn away.

Methods of Cooking

The Moist Methods

Stewing. By this method, the food is partially covered with a liquid (water, stock or milk), and gradually brought towards the boiling-point. Vegetables and seasonings are added to make a satisfactory meal. The food is then simmered without boiling for from 1½ to 2½ hours. The pan or vessel should be closely covered during the cooking. During this process, the connective tissue between the muscle fibres gradually gelatinises, causing them to become looser. The fibres become soft and more tender; some of the natural juices are extracted from the meat to enrich the gravy and so they are not wasted. This method is eminently suited to the rougher, coarser cuts of meat of a cheaper quality. The long, slow cooking at a low temperature is essential to success. It is usually considered an economical method of cooking, as it saves time and effort in preparation and cooking and gives a cheap and easily dished up meal.

Boiling. In this method of cooking, the food is plunged into water which has reached the boiling-point and is in sufficient quantity to cover the food. (The boiling water will coagulate the albumin in meat, eggs or fish, and this will form a coating or seal on the outside of the food, through which the natural juices of the food do not easily escape.) It is usual to lower the temperature after this result has been achieved, and the food is then cooked more slowly to prevent it becoming broken or ragged. (It is obvious that some of the natural juices from the outside of the food will be removed, and the water in which food has been boiled should not be thrown away, but used for stock. Where starchy food is concerned, the water must boil or the starch will not be cooked, but again the cooking should not be too rapid or the heat too intense, or the starch grains will be lost from the outside of the food, as, for example, in boiling potatoes.

Steaming. The steam which arises from rapidly boiling water is most penetrating and food so cooked is softened without losing its natural juices or becoming sodden with water. For this reason it can be considered a more 'conservative' and lighter method of cooking than boiling. The food should be placed in a steamer over a pan of boiling water, covered, if necessary, with greaseproof paper and steamed till it is tender. Alternatively, such foods as puddings can be placed in a basin standing in a pan of boiling water, which should only come halfway up the side of the basin. The steam will surround the basin and cook the food, but care is required to see that the water does not overflow into the basin and make the pudding sodden.

Small fillets of meat or fish may be steamed by placing between two plates, which are then placed over a pan of boiling water. Food in a steamer or a pan should be closely covered, but it is necessary to add fresh boiling water at intervals, as the water will quickly boil away.

The Dry Methods

Baking and Roasting. Roasting is cooking in front of a red-hot fire. Its place has largely been taken by placing the food inside a hot oven heated by coal, gas or electricity. In both cases, the food—this applies particularly to meat—is subjected to dry heat. The albumin on the outside of food is hardened and a seal made through which the juices of the meat do not readily penetrate. The fat, however, melts and runs out, and is caught in the pan below. A certain amount of evaporation takes place, reducing the size of the food and, since the outside may become too dry and hard, it is usual to baste meat or fish while it is cooking by pouring hot fat over it at intervals. After the setting of the albumin and when the food becomes lightly browned, the heat should be reduced. Tender joints are most suited to this method; tough pieces of meat will tend to become tougher if baked or roasted. Double baking tins,

which are self-basting, are useful for baking joints which are of poor quality. The steam in the closely covered baking tin helps to make the meat tender without its losing the 'roast' flavour.

Grilling. Only small, tender pieces of food, such as fillets, chops, small fish, sausages, etc., should be grilled. The earliest method of grilling was to place the food over a red-hot fire and cook it quickly by dry heat. Later a grid iron was introduced to fit over a coal or coke fire, but the invention of gas and electric grills in which the heat is thrown down from above on to the grid iron is a simpler and more reliable method.

The food should be placed close to the red-hot grill in order to seal the food and prevent the wastage of juices. It should be turned several times, and the use of a fork for turning should be avoided, since this will pierce the coating on the outside. From 5 to 15 minutes is the time required for grilling, for, as a rule, grilled meat should not be overdone. It is a quick, easy and digestible method of cooking, if used for the right type of food.

Braising. It is a combination of baking and stewing or steaming, and is useful for hard and tough pieces of meat or fowls, which must be made tender before they can be browned.

The meat or the chicken is cooked first by gentle simmering or by steaming, according to the weight of the joint. When tender, the meat is removed to a roasting tin with a small quantity of the liquid and allowed to bake for a short while, until the outside becomes crisp and brown.

Frying. Fat, when heated, will melt and any water it contains will evaporate. It becomes gradually hotter until its temperature exceeds the temperature of boiling water, fat having no fixed boiling-point. As the temperature of the fat is so high, the method is only suitable for small, even, tender pieces of food, which quickly become crisp and brown. If the temperature of the fat is reduced by placing large quantities of wet food in the pan, the fat will penetrate into the food, giving a greasy, sodden

result. Some foods which do not harden with a coating when heated, or which readily fall apart, should be coated with batter or with egg before being fried.

Foods already rich in fat such as chops, herrings, sausages, require a very small quantity of fat in the pan, and this method is called dry or shallow frying.

Other foods, such as rissoles, fish-cakes and white fish, can be coated and fried in a deep pan of fat; this is called deep frying. However well cooked they may be, fried foods are coated with fat and, for this reason, are not considered very digestible.

Special Methods of Cooking

Hay-box Cookery. In this method of cooking, use is made of the fact that hay and some fabrics are bad conductors of heat, and that when a vessel can be surrounded and covered with hay—if the contents have already attained cooking heat—the cooking process will continue. A deep wooden box is lined and filled with hay, a nest or space being left in the centre to receive the casserole or pan. The food is prepared and cooked for a short time, according to its nature, and then, while still boiling, transferred to the hay-box. A pillow filled with hay should be made to cover the top and a lid fastened down over the contents. (See Fig. 16). Such foods as porridge, stews, dried fruits and milk puddings, if left for several hours, will be found to be perfectly cooked and will only require bringing once more to the necessary temperature for serving. By this means, porridge can be left to cook overnight and will be ready for breakfast next morning. Each individual hay-box will probably differ a little and will require some experiment before times for cooking can be definitely settled. It is not wise to leave meat for more than three hours in a hay-box, for, at the reduced temperature, it may go bad.

Pressure Cooking. Pressure cookers are now manufactured which make use of the high temperature of steam under

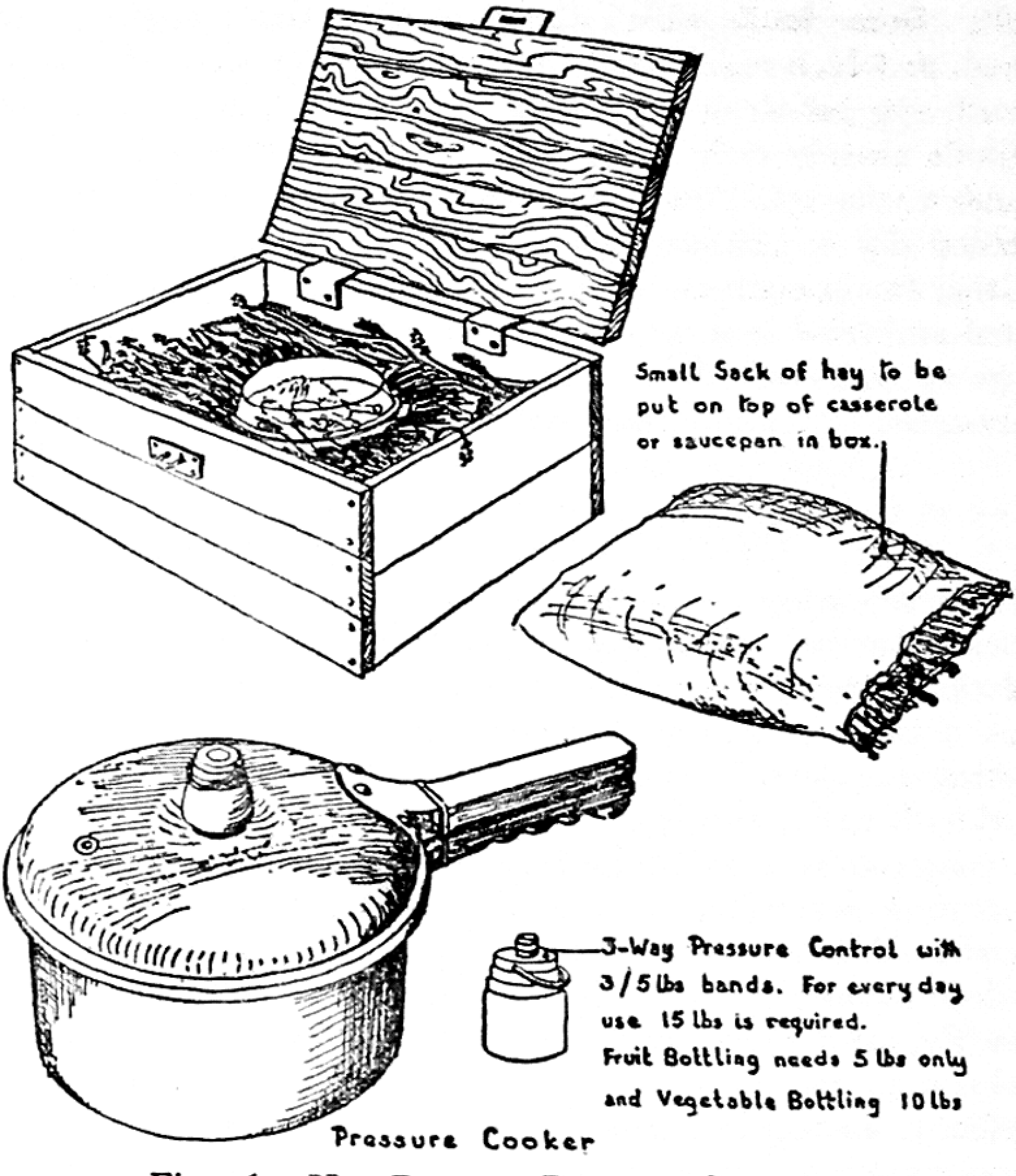


Fig. 16. HAY BOX AND PRESSURE COOKER

pressure. This method is so rapid that its use may completely revolutionise the time required for the preparation of meals. Food so rapidly cooked retains its valuable protective elements, vitamins and mineral salts, and is greatly improved in flavour. It cannot be used for the dry method of cooking, grilling and roasting, or for frying, nor for food which requires manipulation during cooking. It is, therefore, particularly of use for soups,

vegetables, stews, tough foods, for steamed puddings and many similar purposes.

The equipment consists of a deep pan with thick sides and a closely fitting lid, which has to be correctly adjusted and which should not be removed while the steam pressure is fully on. The food is placed in the cooker—with separate containers, several types of food may be cooked at the same time—but it is necessary not to fill it more than half-full with liquid, or three-quarters-full with solid food. Add exactly the amount of water which is necessary for the cooker in use: this instruction will be given with the cooker and, frequently, a measure will be provided, and the amount should be rigidly adhered to. The lid is now closed and the steam escape left open. The cooker is then placed on the stove, whether gas, electricity, etc., at the highest heat. The liquid is brought quickly to the boil and the air driven out. When steam comes out from the escape, it should be closed; the pressure will then rise, usually to 15 lb. per square inch, at which the steam makes a hissing noise as it is forced out through the escape. The gas or other form of heat should be reduced to low, and the cooking time reckoned from this moment. The times for cooking various dishes are supplied with the cooker, and since the cooking is so rapid that a few minutes only are required, it is very necessary that the food should not be overcooked by wrong timing. There are various types of pressure cooker on the market whose adjustment and use will vary a little; the principles given here will be found to be the same. (See Fig. 16.) Some types of cookers are provided with three different pressure weights, 15 lb., 10 lb. and 5 lb. For most purposes the 15-lb. pressure is required; for bottling vegetables the 10-lb. pressure, and for fruit bottling the 5-lb. pressure.

When the food is cooked, the pressure must be reduced by cooling the cooker quickly. The lid cannot, as a rule be removed until this has taken place. The cooker is cooled by

either holding it under the cold-water tap, letting the water flow over the bottom and sides only, or by standing in a basin of cold water for 10 seconds.

A safety device is fitted to the cooker to prevent accidents, but care must, nevertheless, be exercised in its use. In particular, the small escape through which the steam issues before the pressure is applied should never be allowed to get blocked, as may happen if starchy food becomes lodged there.

Some typical times for cooking are:

Stewed mutton .	15 minutes
Tripe and onions .	15 minutes
Tomato soup .	5 minutes
Oxtail soup .	45 minutes
Old bird .	35 minutes
Suet pudding .	45–55 minutes
Carrots .	5 minutes
Potatoes .	8–10 minutes

13

Cleanliness

The term 'cleanliness' may cover many aspects of freedom from dirt, from the asepsis of modern surgery to the mere absence of noticeable grime.

From the point of view of the home, dirt may consist of: (*a*) Inorganic substances, such as sand, soil grit, ash and even volcanic dust. (*b*) Organic substances, such as carbon, the result of imperfect combustion in the form of soot. Other examples are fibres of cloth, wool, silk cotton; cells from the human skin, from animals and from birds; particles of flour and starchy substances, pollen and other vegetable substances; grease and oil from foods and cooking, and from the human and animal hair and skin; yeasts, moulds and bacteria, some of which are the germs of disease. A large proportion of these two kinds of substances, finely powdered, make up the dust which forms part of the atmosphere, and which can be seen as motes in a sunbeam. When these fine particles settle on surfaces, they make a grey or black film or deposit—the characteristic of a dusty room. If the particles settle on a sticky or greasy surface, they form a paste-like substance which is difficult to remove.

A rough surface also holds the dust, and for this reason a smooth or polished surface, whether it be of furniture, metals or fabrics, keeps clean longer than others, and much of the work involved in domestic cleaning is in fact that of polishing in order that dust may be easily removed when it settles.

Removal of Dirt

Dust or dirt can be removed by (*a*) washing, (*b*) beating, (*c*) sweeping and dusting and polishing with wax polishes, and (*d*) suction.

Washing. Washing with warm water and soap dissolves the soluble substances, melts and emulsifies grease, and these are all removed by the water. This method is essential for the cleanliness of clothing, bedding, floors and other surfaces. The use of a disinfectant in the water is advisable where there are risks of infection in sick-rooms.

Beating and Shaking. Beating carpets, covers and bedding has the effect of bringing engrained dust to the surface and out of the articles. If carried out in the open air, the dust will be carried away, but it is a clumsy and dirty method and is liable to deposit a considerable amount of dirt on the beater.

Sweeping. Sweeping is useful for removing litter, but is apt to raise a large amount of dust into the air, which will gradually descend again, rendering the cleaning ineffectual. If a carpet or other surface is slightly damped with, for example, moist sawdust, or tea-leaves or with patent preparations, this effect will be minimised to some extent, but the method cannot be considered truly hygienic.

Dusting and Polishing. In this case, the dust is gathered into a cloth or mop, which is shaken or washed after use. A slightly damped duster will cause the dust to adhere to it, but will leave smears on furniture unless subsequently polished. A duster or mop sprinkled with linseed oil or paraffin will also collect dust and will improve and brighten the surfaces on which they are used. Polishing furniture and floors with floor polish, or bees-wax and turpentine, will make them more easily dusted and cleaned, and will preserve the wood. In all cases of polishing, whether wood or metal, it is the friction applied or the 'elbow grease' which is largely responsible for removing the dirt.

Suction. The method of gathering dust into a bag or container by means of suction with a vacuum-cleaner is the most modern and most effective way of removing either loose or ingrained dust from floors, carpets, furnishing fabrics, etc., and from those parts of a house where dust collects, e.g. shelves. The dust thus removed is emptied from the container and

burnt. Some types of cleaners both beat the fabric and suck up the dust, which makes for even greater cleanliness. The house that is cleaned by this method is cleaner and brighter than one cleaned by the more laborious, old-fashioned methods, though obviously the necessity for washing fabrics still exists.

Bacteria and Viruses

Viruses and many bacteria are our natural enemies. They may be of the type which produce a specific infectious disease, such as measles, influenza, common cold, or smallpox, caused by viruses, or they may be of the type which are capable of producing a range of diseases, according to the organ they effect. To obtain the absolute cleanliness or asepsis called for in modern surgery, all living organisms of any type must be destroyed, as it is impossible to discriminate between the harmful and the harmless. When once surgical instruments or dressings have been sterilized, they must not be exposed to the air, but should be kept in a sealed container until the moment of use.

For domestic purposes, it is desirable that food, milk and water should be protected from all impurities that may enter, either from dust or from contact with other organic substances. For this reason, collections of dust and dirt, decomposing matter or animal refuse must be avoided in the house and its immediate surroundings. Because bacteria can be carried on the hands and beneath the nails, care must be taken by those preparing food to wash their hands frequently, and to be cleanly in their habits.

Single-celled living organisms are found in every situation, in water, milk, foodstuffs, in the soil and in the air. They are taken into the human body and, in some cases, assist its functions. The majority of these cells are harmless to human life and some are beneficial; for example, the yeasts which assist in the fermentation of wine and beer, and in breadmaking, and are a source of vitamins. The moulds, although they cause

deterioration in some foodstuffs, are considered desirable in others—for example, in cheese—and are not positively harmful. Others assist in the rotting or decomposition of organic substances, such as animal and vegetable refuse. When, however, they enter our foodstuffs and decompose them, the poisons produced by putrefaction changes are harmful and may cause food poisoning.

To destroy bacteria, the following methods are employed. (Viruses are more difficult to deal with but can be destroyed by some antiseptics).

(*a*) *Exposure to the Fresh Air and Sunshine.* Clothing may be disinfected by hanging in the sunshine for some hours, but this method cannot be relied upon completely, as it is impossible to ascertain at what moment the disinfection is complete. Such exposure is best carried out in conjunction with some other method.

(*b*) *Applying either Dry or Moist Heat.* Water, food or clothing that has been boiled for 15 minutes is free from germs and their spores, and is said to have been sterilised. When these articles are exposed to the air again, they will, of course, collect further bacteria, and so the sterilisation is only temporary. By the exclusion of air, as in bottling and canning, food can be sterilised by heat and further entry of bacteria prevented by creating a vacuum and completely sealing the vessel.

Milk can also be partially sterilised by pasteurisation, which involves heating it slowly to a temperature of 140° F. and then cooling the vessel rapidly while it is still sealed.

(*c*) *Use of Antiseptics and Disinfectants. Antiseptics* are substances which have the power of arresting putrefactive organisms in the living tissue and must therefore be of such a nature that they can be applied to the body without injuring such tissue. Antiseptics are used in dressing wounds or applying to infected areas of the skin. They include such simple substances as salt, boracic powder, potassium permanganate, iodine and peroxide of hydrogen. Proprietary pre-

parations, such as Sanitas, Lysol, Jeyes' Fluid and Dettol suitably diluted are much used. Alcohol and ether are used in the surgery, but some of the latest developments, such as the use of penicillin and other new drugs, can still be prescribed only by scientists and the medical profession.

One of the most useful of antiseptics for first-aid purposes is saline solution, made by dissolving 1 teaspoonful of salt in 1 pint of warm water. It can be used for washing cuts and abrasions, for gargling and for injuries to the eyes.

Most antiseptics are not poisonous, but are not intended for internal use and may do harm if swallowed or used in too strong a solution. They should be plainly labelled and locked up when not in use.

Disinfectants. Disinfectants are those agents or materials which will destroy both germs and their spores; they are often poisonous and frequently of a corrosive or burning nature. When they are solutions some cannot be applied to the human body except in very weak form, and the others are totally unfitted for this purpose. They are used for disinfecting clothing, furnishings, toilet receptacles, drains and sewers, walls, floors and other surfaces.

True disinfectants are of three types: (*a*) heat [already dealt with], (*b*) chemicals, (*c*) gases and fumigants.

Chemical Disinfectants. These are usually sold sealed, labelled 'Poisonous', and should be carefully stored and diluted according to instructions. They include *carbolic acid*, which is used in a solution of 5 to 6 parts to 1,000. At one time, it was much used for surgical purposes, but the newer drugs have superseded it. It can be used for steeping infected clothing, for drains and for floors. Various coal tar preparations and proprietary preparations, such as Lysol or Izal, are now used in preference to carbolic acid. *Corrosive sublimate*: tablets of this highly poisonous disinfectant can be obtained and are coloured blue, and used in the proportion of 1 to 1,000 parts of water. *Formalin*, or a 40 per cent. solution of

formaldehyde, is a potent disinfectant and is non-poisonous. *Chloride of lime* can be used for drains and sewers, and similar purposes.

Fumigation by Gases. Only a certain number of the poison gases are suitable for killing germs on domestic premises. Sulphur dioxide gas is produced by burning sulphur, usually obtained in the form of a sulphur candle, in a room made as air-tight as possible by pasting up all crevices, windows, fireplace and doors with strips of paper. All articles that can be cleansed by boiling or in the disinfecting station should previously be removed, and other articles opened out for impregnation by the fumes. The sulphur candle is placed above a container of water to minimise the risk of fire and, after igniting it, the room is sealed and left till the following day. The room then requires airing and washing, to remove the smell of the gas. Chlorine gas can be obtained by adding strong hydrochloric acid to chloride of lime in a room sealed as just described. The gas is highly injurious if breathed.

Formaldehyde is now used more than either sulphur dioxide or chlorine. It can be applied to the room either as a vapour or a spray. The vapour is produced by means of a special lamp.

Deodorants. These substances are merely used to give a pleasant odour, and may do harm by masking a disagreeable smell which requires investigation and removal. Various scents, pine odours and camphor are examples.

Chlorophyll, the green colouring matter of plants, has been found to have the property of absorbing odours, though it is not a masking scent as are the deodorants previously mentioned. Preparations are now being manufactured that remove odours from the kitchen and the sick-room, and for toilet purposes.

Insects and Vermin

Insects and vermin of the type which infest dwelling houses and their occupants are carriers of disease. Of these one of

the most difficult to control is the *common house-fly*, on account of its freedom of movement. Flies lay their eggs in organic substances, preferably stable manure, on which the young maggots can feed. Since the almost complete disappearance of horse-drawn vehicles in towns, flies are not quite so numerous as they were, but in country districts they still abound, and even a single fly should not be disregarded. The fly is a dirty feeder and unclean in its habits. It alights on filth, which adheres to its legs and feet, and this, and the bacteria concerned, are deposited on our food; its excretions are also deposited there. The fly is a prolific breeder, and, in favourable circumstances may become very troublesome.

Many methods have been devised for catching and killing them but the modern D.D.T. powder and sprays are deadly to the fly and should be made use of whenever possible. Food should be covered with muslin or paper or stored in safes or refrigerators to prevent contamination. The removal of suitable breeding places and the utmost cleanliness of the precincts of the house are the best safeguards.

The mosquito does not attack man's food, but is a parasite which bites him in order to drink his blood. In so doing, the mosquito deposits the bacteria which are responsible for malaria in the bloodstream. Malaria has been responsible for widespread disease and misery, and in the past has made some parts of the world uninhabitable. Two methods of dealing with this menace have been used: (*a*) the covering of stagnant water in ponds, marshes, etc., in which the larvæ of the insect live, with a thin film of paraffin, in this way suffocating the larvæ which cannot reach the air, and (*b*) the use of quinine, which, if taken regularly, will minimise the effects of the disease.

Rats and mice are most destructive of foodstuffs, not only because they feed on them, but because they also waste and pollute them. Germs are carried by rats from the sewers and ditches they infest, and the parasite of the rat, the flea, is a carrier of the plague. Both rats and mice are difficult to

destroy; traps and poison may get rid of some, but do not permanently remove them. Fumigation with chlorine gas or sulphur dioxide is resorted to on ships; in the house the domestic cat, if a good mouser, will frighten away both rats and mice.

Cockroaches and *steam flies* infest bakeries, restaurants and old kitchens, and are both dirty and unpleasant. Fortunately, they can now be destroyed with D.D.T. and the cockroach is being steadily eliminated.

Ants, while not frequently contaminated with injurious matter like some vermin, will nevertheless spoil sweet foods, such as jam, honey and syrup by becoming engulfed in them. They are best destroyed by being traced to their nests, which can then be treated with D.D.T. or boiling water.

It should be remembered that germs of disease can be communicated to others by personal contact; by handling of food with unwashed hands, and by carelessness in matters of personal hygiene. Cleanliness of the person and of clothing is, therefore, of the greatest importance, and these are dealt with in subsequent chapters.

14

The Use of Cleaning Materials

WATER is a natural cleanser and, by its solvent properties, will remove much dirt, especially if it is forced through fabrics or over surfaces. Grease, however, is not dissolved by water, although it may be melted by warm water and carried away. Much of the dirt which collects in a house, and on clothing and utensils is mingled with grease from cooking and from the natural oils of the hair and skin of human beings and animals. Washing in water alone will therefore not remove such dirt, and cleaning materials are required for the purpose. These are usually alkaline in character, or have an alkaline basis, with sometimes a mixture of abrasives.

THE NATURE OF FATS AND OILS

Animal fat is made up of fatty acid and glycerol, the acids varying according to the source from which the fat is obtained, for example, stearic acid, in association with glycerol, is found in the fats of mutton and beef. It is possible to split fat into its two component parts by the addition of an alkaline substance mixed with water. The alkali and the acid neutralise one another, forming a salt which is neither acid nor alkali, and the glycerol is liberated and is dissolved in the water. This process takes place in soap-making.

SOAP

Soap-making. Washing soap is made from animal fat, caustic soda and water. When these are boiled together, saponification takes place, and the alkali and the acid from the fat unite to form a salt, sodium stearate, which floats on top of the

liquid and hardens when cold to make a layer of soap. This soap, unlike fat, is soluble in water, and dirt, with the grease which holds it will be removed and either dissolved in the washing water or, if insoluble, will sink to the bottom.

In making soap for household purposes, a certain excess of caustic soda is used and the resulting soap holds the soda as free alkali. When soap is used for cleaning purposes, the free alkali is conveyed to the grease by the soap and saponifies it—that is, the free alkali combines, with the acid in the grease, thus loosening the dirt. It also breaks up oil droplets to form an emulsion which can be washed away in the lather. The excess alkali also acts as a water-softener, and soap can be used to soften hard water. For toilet soap, called superfatted soap, only the smallest quantity of free alkali is included, and such soap is suitable for delicate skins; the fat used for toilet soap is of vegetable origin, from palm or olive oil. The natural oil in the the skin, which holds the dirt, is thus saponified, made soluble in water and the dirt removed. A soap too strong in free alkali will remove too large a quantity of the natural oil and a dried and chapped skin will result.

Soft soap is made by boiling coarse oils or tallow with the alkali, caustic potash. The result, potassium stearate, does not harden as does sodium stearate, but forms a jelly.

Soap Flakes. The best-quality soap flakes are made from pure washing soap, so finely flaked that they dissolve readily and quickly in water. They are used for washing delicate fabrics, such as silk, wool and lace, which would suffer if hard soap containing much free alkali were rubbed upon them.

Melted Soap or Soap Jelly. Household soap can be shredded or grated finely, dissolved in hot water and used for washing delicate fabrics in place of soap flakes. When allowed to cool, the melted soap will form a jelly which readily dissolves in water. Small pieces of soap which might otherwise be wasted can be saved till washing day and melted down in this way. Use 1 pint of water to ¼ lb. of soap.

Dry soap powders are usually stronger than soap flakes. There are many proprietary powders on the market, varying considerably both in composition and in strength. The coarser powders, in addition to powdered soap, contain washing soda finely ground. Their use is not advised either for delicate fabrics or for the skin and hair.

Soap containing Abrasives. Soap intended for scrubbing wood and for heavy cleaning may have finely-ground abrasives, such as bath-brick or silver sand, added. They are not suitable for toilet purposes or for washing clothes.

Soapless Detergents. Most detergents in present-day use are petroleum derivatives, although compounds of sodium and phosphates and other substances are used in proprietary washing powders. They are added to water and readily dissolve grease and dirt which are then removed by water.

There is no scum or waste, and they are harmless when used for delicate fabrics, such as silk or wool; nor do they dry the skin or hair. They have a slightly disinfectant effect, and are therefore useful for sickrooms.

Some detergents can be used in conjunction with soap, but if used alone their complete removal during rinsing is not necessary, as they may even improve the fabric by softening it and brightening colours which have been affected by soap left in from previous washing.

Alkalis Used For Cleaning Purposes

The use of alkalis is recommended for removing grease from crockery, cooking utensils and clothing, owing to the heavy cost of soap and the shortage of fats.

The following alkalis are commonly used to break up fat into small droplets, emulsifying it and so enabling it to be washed away in water:

Sodium Carbonate or Washing Soda. This not only emulsifies grease and dirt, but it is also a water-softener. If used in excess, soda will remove the natural oils of the skin, will shrink

woollens and spoil the colour of printed fabrics, and has a harmful effect upon some metals, removing the surface of tinned articles and blackening aluminium and in time destroying the metal. It is of the greatest value as a grease-solvent and as a water-softener, when used in correct amounts for each purpose, as it is one of the cheapest cleaning materials.

Caustic Soda. This has the same effect as sodium carbonate but is too strong to use freely on account of its caustic or burning properties. It is sometimes used for cleaning neglected gas stoves, but care must be exercised to prevent splashing the skin or the eyes.

Borax is also a grease-remover and water-softener. It has no harmful effect upon animal fibres, and can be used for delicate fabrics and for washing the hair.

Ammonia will remove grease and soften water. It is useful in small quantities for washing blankets and woollens or for toilet purposes. It has, however, a ***strong burning*** action and is a dangerous poison.

Other Grease Removers

Paraffin Oil. This has a solvent effect on grease and, with hot water or added to the water in a washing boiler, will clean articles stained with heavy machine oil, such as engineers' overalls. It is also used to remove stains from porcelain sinks and baths. It is inflammable and must not be carelessly used.

Petrol is a very potent grease-remover, but it has such a low flash point and is therefore so inflammable and dangerous that it should never be used near a naked light or fire. So dangerous is it that the householder should not attempt to use it for dry-cleaning purposes.

Benzine will remove spots and stains from clothing, but it tends to leave a ring round the mark. It is advisable to work inwards towards the stain to avoid marking the fabric. It also is highly inflammable.

Fullers earth and French chalk will remove marks from woollen

and silk fabrics, and from carpets and furniture, by absorbing the grease. It should be made into a paste with water, applied to the article, and then brushed out when dry.

Hot Iron and Blotting Paper. Grease spots can be removed by placing a piece of blotting paper above and below, and pressing with a moderately hot iron. It should be remembered that woollens can be scorched by too hot an iron, while the paper above may appear unmarked.

Removal of Stains other than Grease

All stains should be removed as soon as possible after they have occurred. When still wet or fresh, they can be more readily removed.

Tea or Coffee Stains. If wet: wash out with boiling water to which a little borax has been added. If dry: steep in soda and boiling water.

Fruit Stains. If wet: rub the stain with salt; this does not remove the stain, but renders it more easily washed out with soap and water. If dry: rub the mark with methylated spirit.

Ink Stains. If wet: rub lightly in milk; a light blue mark will remain, which will wash out. If allowed to dry, the ink will leave an iron-mould stain after the blue colouring has washed away.

Dry Ink or Iron-mould Stains. These are iron oxides and require an acid to remove them properly. Salts of lemon or oxalic acid are the most effective, but they are deadly poisons and must be used only by responsible persons, and with the greatest care. Boiling water should be poured through the stain; the dry powder is then applied with a piece of wood, such as a match stick, and boiling water once more poured through. The fabric should be quickly rinsed to prevent the acid rotting it and, if the stain is still visible, the process should be repeated. When attempting to remove a stain from coloured fabrics, the acid should be dissolved in water and the stain dipped alternately into the solution and into cold water to avoid fading the

colour. Dry ink can also be removed by chlorine preparations, which bleach the blue colouring matter.

Paint Stains. Rub lightly with turpentine before the paint dries.

Tar Stains. Rub with grease, such as lard. The grease must then be washed away with the softened tar.

Grass Stains. Methylated spirit or use a bleaching liquid made from chloride of lime and soda, diluted with water.

Mildew Stains. Use a bleaching liquid as above, and hang in the sunshine.

Blood Stains. Loosen by steeping in cold water. Then wash out in the usual way.

Other Cleaning Materials

Materials used for scouring surfaces are known as abrasives, and include bath-brick and fine sand, such as silver sand. They are used for some metals—for example, steel and stainless steel—for woodwork and stone floors.

Whiting has a slight abrasive action, but does not scratch soft metals.

Emery paper is used for burnishing steel.

Metal Polish contains a spirit and a fine powder, such as whiting. Such polishes should not be used for cutlery or cooking utensils.

Proprietary powders, such as Vim, Glitto, etc., are useful for removing grease and stains. The best of these do not contain harsh abrasives.

15

Kitchen Planning and Equipment

THE kitchen is one of the most important rooms of the home; it is the centre of the family well-being, since the cooking and much of the cleaning and management are conducted from it. For this reason, it should be well-planned to save labour and increase efficiency; it should be clean and attractive since the housewife has, perforce, to spend much of her time here. In the modern small dwelling, there is a tendency to make the kitchen too small for comfort and a kitchenette, with a sink, gas stove, no heating and an ill-fitting back door which allows draughts and rain to enter, is not conducive to good household management or comfort. Where it is necessary to save space and cost, the combined kitchen and living room, with an alcove for dining table and work is, perhaps, to be preferred. On the other hand, the old-fashioned house with a separate kitchen, with a large range, dark cupboards and stone flagged floor, with possibly several steps to go down into an equally large scullery, is most tiring and difficult to run.

The ideal kitchen should be so planned that the various appliances used for one operation, such as cooking or washing, are placed next to one another, so that the housewife can perform her task with no more movement and walking than is absolutely necessary. For example, the table for cooking is placed next to the kitchen cabinet or cupboard, the gas or electric cooker is within easy reach and, beyond this, the sink, draining board and china cupboard; the pantry or storeroom being within a few paces of the cooking equipment. Where the kitchen is used for laundry work, the electric washer or gas boiler should be placed next to the sink, if necessary with a detachable draining board

above, in order that the clothes may be easily passed for rinsing into the sink. Space beneath the sink may be used for laundry equipment and cleaning materials. There should be some form of heat in the room, either a small closed stove, burning coke or anthracite, heating the water or, if the house is all-electric, a radiator fitted into the wall. In this case an electric water heater or an immersion heater provides the hot water.

The kitchen sink should be placed against the outside wall under a window and, where it is possible to have more than one window, the work table should be placed near it in order that the housewife may get the benefit of the light and the view.

The walls are more readily cleaned if tiled or half-tiled; the junction of the walls and the floors should be rounded to facilitate cleaning. Light colours or pastel shades are preferable for walls and fittings, giving brightness to the room. The floor should be tiled or of some composition; a wooden floor is not desirable, as it is difficult to clean. Moreover, a wooden floor requires a ventilation space beneath, and this may encourage mice and insects to congregate. There is now on the market a new rubber composition supplied in 9 in. × 9 in. tiles, in plain or marbled colours, with none of the disadvantages of rubber flooring, which is difficult to keep clean. An added advantage for use in a kitchen is that these tiles will not burn. The makers will only allow them to be laid in a black emulsion by their own craftsmen, but their purchase is a long-term policy of economy.

Good windows throwing light on sink, stove and worktable are important, and lights over sink and stove of 60 watts, with a central enclosed light of 100 watts, all with separate switches, are advisable for a large kitchen.

The cooking stove may be a gas stove, electric cooker or one of the new type burning smokeless fuel kept permanently alight. A gas stove should if possible be placed against an outside wall, with a pipe inserted in the wall to remove fumes, steam, etc., from the oven. Unless the stove is raised on feet, it is advisable

to have it placed on a stone base, and it should be possible to turn off the gas at the entry pipe. Some form of automatic oven control is desirable. An electric cooker requires no ventilation, nor does the wall behind it become stained in use. A cooker with two solid hot plates, a grill boiler and an oven with two elements and a load of 7 kw. is usually large enough for a family of six persons. A thermometer or a thermostatic control is necessary. The new type of cooker consuming coke or smokeless fuel is invaluable in country districts where the house has neither gas nor electricity; it is economical in use and can be used for water-heating and for large-scale cooking—it may be preferred even where other types are possible. Grates with an oven over the top and a hot-water boiler behind, of the bungalow type, are installed in many small houses, and these are good if they have been properly fitted and if the somewhat intricate flues are cleaned regularly.

Another ingenious method of heating is obtained by placing the living-room and kitchen grate back to back, the living-room fire providing the heat, which is conveyed to a small oven in the kitchen. Proper fitting and cleaning are again essential.

Sinks and Draining Boards. Sinks can be made of stainless steel or of porcelain; the draining board may be of stainless steel to match the sink or of sycamore wood if the sink is of porcelain. Deep sinks are to be preferred to shallow, as they can be used for laundry purposes and are not so likely to wet the housewife who is using them. The height of a sink is of importance, the tendency being to place it too low for the housewife's comfort. A draining board on each side of the sink is of great convenience in washing up. The sink should be kept clean, free from grease and the pipe free from tea leaves, potato peelings, etc. Abrasive substances will remove the surface of the porcelain sink and it will pick up dirt again more readily. If unusually stained, it can be cleaned with paraffin or with one of the chloride bleaches on the market. A mild abrasive such as whiting on a damp cloth can be used on the metal fittings and for cleaning a

metal sink, though normally hot, soapy water is best for metal sinks and draining boards. Wooden draining boards must be scrubbed daily and wiped as dry as possible.

Kitchen Cabinets and Cupboards. It is a great help to have the cooking utensils and cabinet containing the ingredients, such as flour, sugar, coffee, etc. (each in its separate labelled tin), so arranged that they are in their correct positions when required. Enamel or stainless fittings, table tops, etc., are most useful as they can be readily wiped over.

Storeroom and Larder. The storeroom or larder should be as conveniently placed with regard to the position of cooking stove, sink and work table as possible. It should be dry, cool and well-ventilated. As we have seen in Chapter 1, it is best if it faces north. Dark, damp and stagnant conditions encourage the growth of moulds and fungus, and food will be contaminated if kept in such a room. The walls should be tiled or white-washed and the floor tiled or concreted. The window should be fitted with a gauze sash, if possible, to allow for ventilation and to prevent flies entering. A marble or concrete slab at one end is useful for storing milk, butter, etc. In order that goods can be readily seen, the shelves should not be too wide; they should be covered with clean paper or oilcloth.

Dry foods, such as flour, rice and oatmeal, should be stored in bins or canisters, clearly labelled and accessible. Glass store jars are most useful, as it is possible to see when the goods require replenishing. Jams and preserves are better stored not too near the ceiling, as a cooler position is preferable. Root vegetables are best stored in racks after washing if they are earth-covered. Green vegetables keep best if placed in a large bowl, sprinkled with water and tightly covered. Meat should be kept in a meat safe or covered with muslin or paper; if tightly covered, it will not keep well. Milk should be covered with muslin. Butter, in hot weather, should be placed in a basin standing in a tin of water, covered with clean muslin, the ends of which are allowed to lie in the water.

The modern house or flat is frequently supplied with an electric or gas refrigerator. In this case, the perishable foods will be stored in it and only dry goods and vegetables are stored in a larder. The refrigerator is usually set at a temperature of from 35°F to 50°F, which does not freeze the food, but only chills it. For this reason, foods so stored only keep fresh for a few days; it is not intended to serve as a permanent cold store. All foods should be cold and clean before placing in the refrigerator; foods such as meat, fish and butter should be covered with grease-proof paper and those of the most perishable nature, such as milk, placed nearest to the ice chamber. Since the warmer air tends to rise and carry odours with it, strong-smelling foods, such as fish, should be placed at the top of the cabinet. Green vegetables and fruits should be washed and placed in the bottom; a special rack is often provided for these.

Refrigerators should be de-frosted by removing the food, turning off the current or gas, and removing the ice-box when the frost which has gathered on it has melted. The cabinet should be washed out with warm water containing bicarbonate of soda. Do not use soap, as this may flavour the food. When dry, the ice-box is refilled with water, the current or gas turned on and the cabinet re-packed with the food. Care should be taken not to open the door too frequently.

Equipment which will be found of use in the larder includes scales and weights, measures, pencil and pad and order forms, bread tin or pan, also a stool and steps, if the shelves are not low.

16

Household Appliances

Cooking Stoves

There are several types of cooking stoves in common use. (See Fig. 17.)

(*a*) *Coal Stoves*. Among these are included all stoves burning solid fuel. The old-fashioned oven attached to the kitchen grate or the closed kitchen range burn, coal, although a mixture with coke or coalite may be made. The oven is provided with flues or passages round which the hot air and gases travel, heating the metal of the oven. The soot produced clings to the sides of the flues and will gradually clog them, in which case the hot air cannot pass and the oven will not heat. The use of the oven, therefore, depends largely on frequent cleaning of the flues. This should be done with a flue brush working from the top flues leading to the chimney to the bottom flues on a level with the fire. Various small doors are provided for inserting the brush and removing the soot. To control the heat of the oven, it must be possible to regulate the passage of hot air, and for this reason a draught-regulator is fitted in the top portion of the flue. It is impossible to obtain good results from a coal range without clean flues, a good control by the draught regulator and an adequate and brightly burning fire. The oven will take half an hour to one hour before a cooking temperature can be obtained. A good coal-heated oven gives a pleasant form of cooking; it does not dry or burn the food, gives an even steady heat and browns adequately.

The '*Aga*' and '*Esse*' *cookers* burn smokeless fuel—coke or anthracite—and are of the enclosed type; they will, in addition to cooking, provide a constant supply of hot water and are invaluable in large establishments, such as hotels and

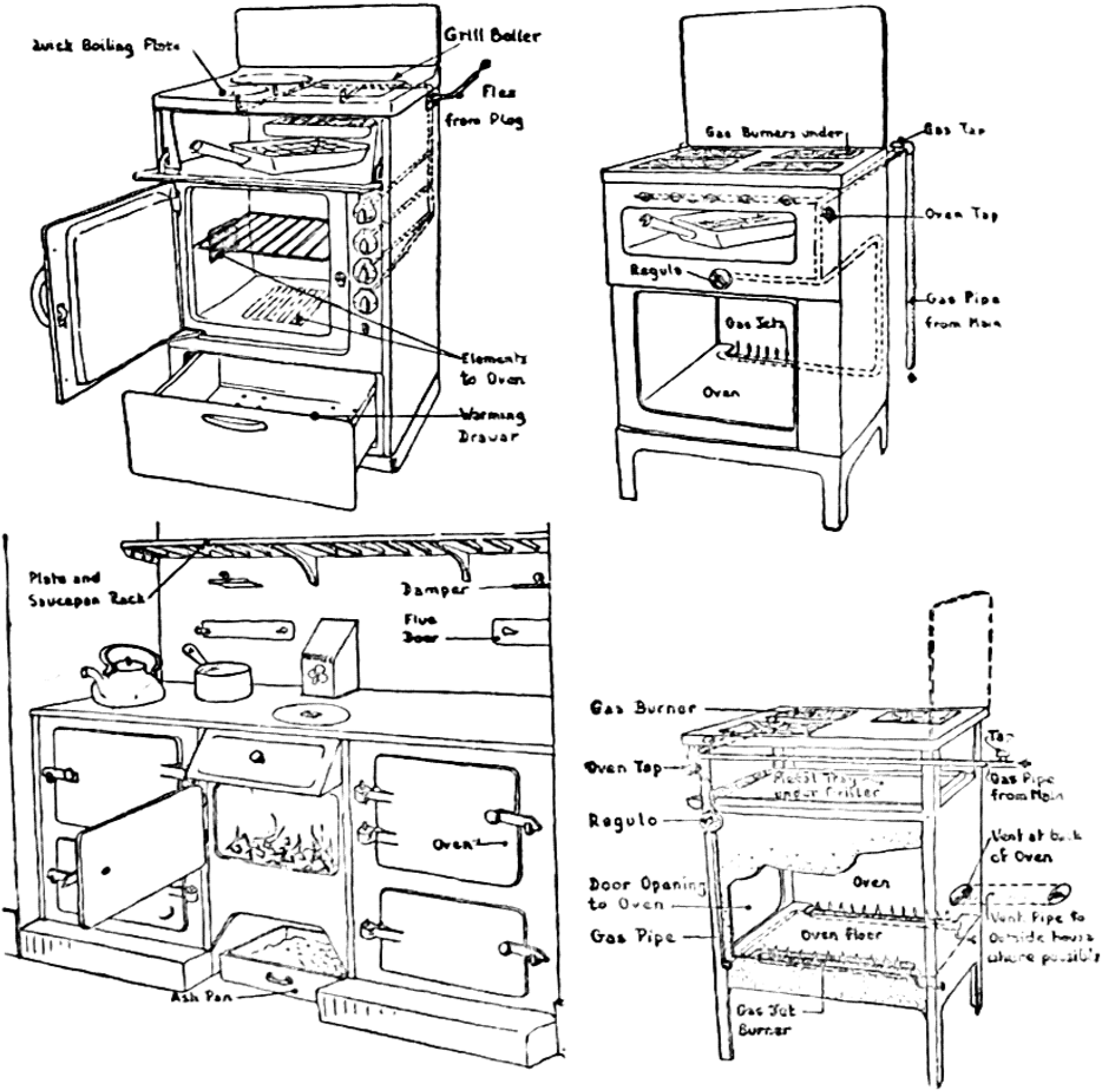


Fig. 17. VARIOUS FORMS OF COOKING STOVES SHOWING DETAILS. *Top left:* Electric cooker with bottom element and warming drawer. *Top right:* Gas cooker with jets at back of oven. *Bottom right:* Side view of gas cooker with jets at each side of oven. *Bottom left:* Coal range with ovens at each side.

boarding-houses where there is much cooking and a constant demand for hot water. They are somewhat expensive to instal, but owing to the fact that the fuel is cheap, they are economical in use, for they burn only about 1*s.* worth of fuel daily and they do produce good results. Their maintenance and cleaning are easy.

(*b*) *Gas Cookers.* Cooking by gas is one of the easiest and most efficient methods; the heat is quickly obtained and easily controlled and, if proper care is exercised, is not extravagant. The gas is brought to the cooker through a pipe which passes along the side and from which branches serve the various burners including those inside the oven. As explained in Chapter 9, the gas is mixed with air before it reaches the burner, giving a blue heating flame. If the flame burns yellow, combustion is imperfect and carbon is deposited on the bottom of the pans. The burners in the oven are arranged along either side at the bottom or, in some models, across the back. The shelves are best of the grid variety; in some models a solid shelf at the top deflects heat downwards for browning purposes; though this is not necessary in the new cookers. The size of the flame can be regulated by the tap, but most models are automatically controlled and can be set to the required heat. Cookers are frequently fitted with a grill at eye-level.

Gas stoves have an air space at the bottom and an opening at the back to remove fumes. Where possible, a pipe should be taken through the wall to remove the fumes from the room.

Strict cleanliness is necessary to maintain the efficiency of the stove; if the burners become clogged, the gas cannot get through, and if the walls and doors of the oven become dirty, the stove will smell unpleasantly. Frequent washing with hot soda water is necessary, and it is helpful to wipe the enamel of the stove while it is still hot.

The length of time required to heat the oven to a cooking temperature of 400–450° F. is 15 to 20 minutes for a medium-sized cooker.

(*c*) *Electric Cookers.* Since electricity does not involve combustion to produce heat, its use is cleaner than other methods; no fumes, no soot or carbon are produced, nor does the smell of cooking escape from the oven. The heat is easily controlled; in the modern cooker it is automatically controlled by a thermostatic device. The cooker is usually placed on a separate circuit of a much higher amperage than the other circuits, 30 amps. being a usual size. The wiring is well insulated and is taken to a switch which serves the cooker circuit only. The wires supply the boiling plates on the top and the elements in the oven. Each plate has its own switch, giving good heat control. The number of the elements in the oven varies; some models have two side elements and one at the bottom; smaller cookers will have two side elements. The elements are not controlled separately, that is, it is not possible to switch on one side only, or the bottom and not the sides. They are, however, like the plates, controlled by a switch. When the boiling plate or the oven elements are switched to 'low', one quarter of the full power is being used, at 'medium',

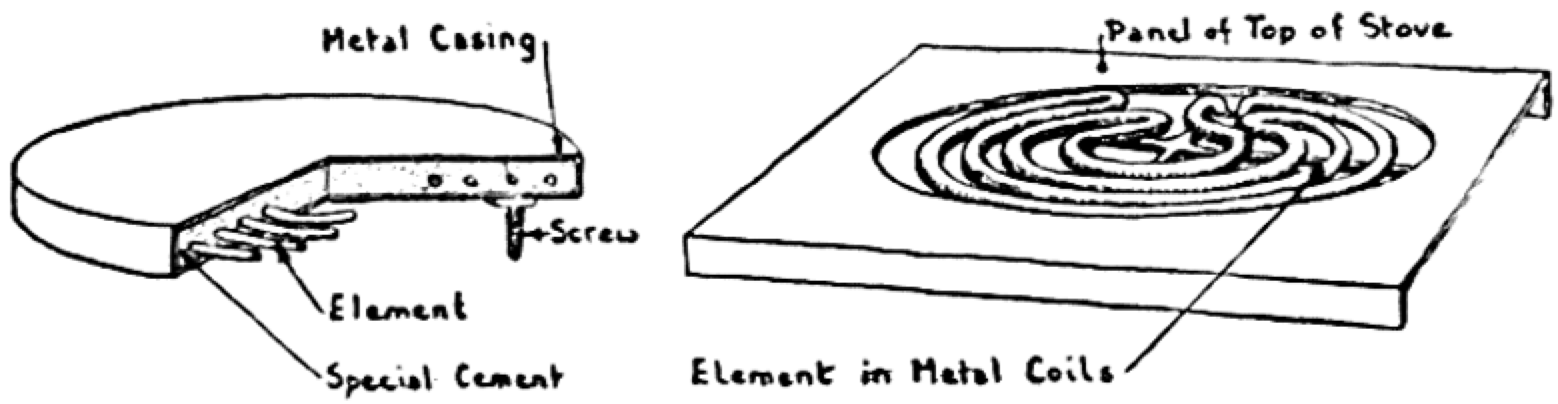


Fig. 18. Two Types of Electric Boiling Plate

half, at 'high', the full wattage. When the heat is automatically controlled the switch indications are different but the method of wiring remains the same. The hot plates can be of three types, (*a*) the solid or totally enclosed plate, where the resistance wires are embedded in a special cement with a casing of metal,

and (*b*) the sheathed element enclosed in a metal tube, the element being suitably insulated, which gives a red-hot, bright heat. The oven elements may be exposed, in which case they are totally covered by a protective bottom to the oven, or are contained in a metal insulated sheath which can be removed from the contacts for cleaning purposes. For grilling an eye-level compartment is often fitted.

The loading of the boiling plate varies from 1 kw. to 2 kw., the grill boiler type being usually 2,000 watts; the oven elements vary from 1,200 watts to 3 kw.

Strict economy should be used or this method of cooking is expensive and the results unsatisfactory. For economy observe these points: (*a*) For solid plates always use the correct type of pans; the pans should be thick, of heavy aluminium and have flat, ground bases, which make a perfect contact with the plate, otherwise heat is wasted. Ordinary pans can be used with tubular plates. (*b*) The pans should be large enough to cover the whole area of the plate or, alternatively, several square pans can be fitted on one plate. (*c*) If the cooker is not automatically controlled, the thermometer should be watched and the switches turned to 'medium', 'low' or 'off', as the case may be, as soon as the necessary heat is obtained. The oven will retain its heat for 15 minutes to half an hour, according to its size, after being switched off, without any appreciable lowering of temperature and will retain a lesser degree for some considerable time. A solid plate will retain sufficient heat when turned to 'low' or 'off' to finish cooking potatoes, etc., when once they have boiled. This retained heat is spoken of as residual heat and good use should be made of it. (*d*) It is advisable to cook a number of dishes for future use when using the oven of an electric cooker, rather than one dish alone.

The cleanliness of electricity used for cookery is one of its special features and, if the cooker is wiped over while still warm after each time of use (first switching off the current), the weekly cleaning will be easy.

Washing Appliances

The washing machine and wash-boilers have taken much of the drudgery out of washing when they can be afforded. The washing machine produces movement and the current consumed is not very great, $\frac{1}{4}$ h.p. being the usual power of the motor. The water for washing, therefore, must be heated before it is put into the machine. Some makes, however, also heat the water. The wash-boiler heats the water and produces movement if fitted with a percolator and the power used is consequently much higher, the average loading being 3 kw.

There are, now, many types of washing machines on the market, the difference lying in the size, finish, the amount of movements involved, such as wringing, rinsing, etc. The usual types are:

(*a*) Agitator type
(*b*) The automatic spinner washer
(*c*) The pulsator type.

Agitator Type. In this machine, the washing is performed by an agitator affixed to the bottom of the container or tub; this may be either raised or flat and has several blades, usually three or four. When the current is switched on, the motor operates the agitator, producing fifty to eighty half-turns of the blades per minute. The effect of this motion is to drive the hot soapy water through the clothes, thus cleansing them. (See Fig. 19.)

Directions are given with each washer but the usual method of washing is as follows: Fill the washer with hot water to the line marked on the interior and add soap powder or detergent to make a lather. For hard water, some form of softener, for example, borax may be added before the soap. Switch on the agitator in order to produce the lather. Having separated the clothes into appropriate piles, it is usual to wash the 'whites' first, these requiring the hotter water. While the agitator is moving, load the clothes gradually into the tub, opening them

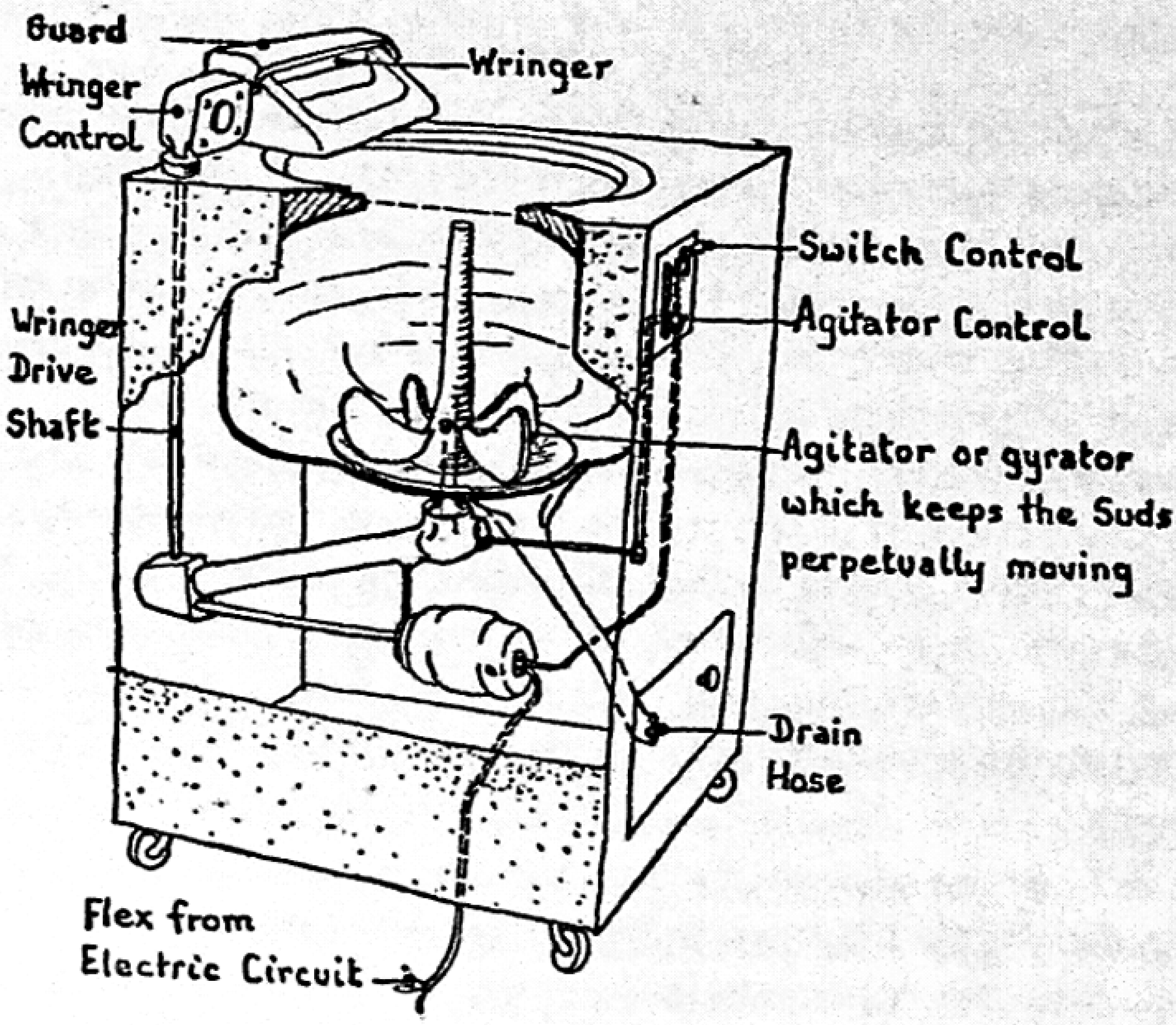


Fig. 19. Electric Washing Machine. Agitator type.

out and feeding them in carefully. Directions are given as to the amount or weight. It is essential not to wash too many articles at once, as the cleaning process depends on circulating the water through the fabric and there must be freedom of movement. The lid is closed to retain the heat and the movement continued for from 2 to 10 or 15 minutes, according to the type of fabric and the extent of the dirt—8 to 10 minutes being an average time for lightly-soiled cotton or linen articles. Most makes of washers are fitted with a wringer, through which the clothes are then passed into a sink or bath for rinsing purposes. The wringer may be worked by electric power and is fitted with a safety release in the event of garments becoming tangled or the fingers caught. If the cleanest clothes have been washed first, a second loading of the more dirty articles can be

washed while the rinsing of the first is in progress or, alternatively, coloured articles or woollens can be washed in the cooler water. An agitation of about 3 minutes is sufficient for woollens.

In some models, a spin dryer is used to remove water from the clothes instead of wringing, still further decreasing the labour. The machine is switched to 'Dry' when the dirty water is pumped out and the water added to the tub for rinsing. The rinsing water is then removed as was the washing water. The clothes are then rotated or 'spun' at a great rate until the water is expelled and removed through holes at the side. When this operation is complete, the clothes are damp only, some being ready for ironing, others requiring drying, possibly out of doors.

Cleaning and care of the washer is simplified by the careful construction—the covering and lining being of non-rusting material and vitreous enamel. Care, however, must be taken to dismantle the loose portions and wipe every part quite dry, after washing out with clean water. Some washers are self-oiling.

Portable table washers are available for washing small articles for nursery use, etc.

The Automatic Spinner Washer. This is a more expensive model than the agitator type, as more processes are undertaken by the washer. The whole process is automatic and the washer is attached to the house hot-water supply and is in a fixed position. The machine steeps, washes, rinses and dries the clothes without further attention when once the clothes have been inserted and the switch turned to 'soak.' The clothes then pass through the washing, rinsing and drying by the spin-dry process in the requisite time, and the small articles are ready for ironing.

The Pulsator Type, though not quite so common as the agitator type, is quick in action. The cleansing action is produced by a revolving pulsator which moves the clothes quickly about in the container, so removing the dirt. The general principles are the same as in the other types of washing machines.

Irons

The following types of irons are in use for domestic purposes:

(*a*) The flat or sad iron
(*b*) The gas iron
(*c*) The electric iron (including the steam iron)

The last type is almost universally used in houses where electric power is installed, but there are still many houses where other irons must, perforce, be used.

Flat Irons. If flat irons are kept smooth and clean, they are most effective, their great disadvantage being that they lose their heat and require changing. The method of heating them is important as soot or smoke will blacken the surface. A flat metal sheet is put in front of a fire on which the iron can be placed; a stove specially constructed to burn coke or a closed range will serve the purpose. If placed over a gas jet, care must be taken to wipe the bottom of the iron several times while it is heating, or the condensation of vapour on the metal will cause discolouration. The iron should be rubbed on bath-brick or powder and well dusted after removing from the stove, before it touches the clothes.

Gas Irons have now been largely replaced by the electric type. A gas jet burns inside the iron and heats the metal, the iron being attached by a flexible tube to the gas supply. The heat is constant, but care must be taken to ventilate the room in which a gas iron is being used, as burning gas consumes oxygen and produces carbon dioxide.

Electric Irons. Electric irons should be attached to a 3-pin plug to fit a 3-pin socket (5 amps.), and not be plugged into a light socket which has no earth wire. The flexible should be well insulated with rubber with a silk or cotton covering and care should be taken not to bend or break it, or to touch the insulation with the iron and so burn it, exposing the live wire. The 3-core flexible makes contact with the iron near the handle and the current passes to a heating element of nichrome wire, sandwiched between two layers of mica for insulating purposes.

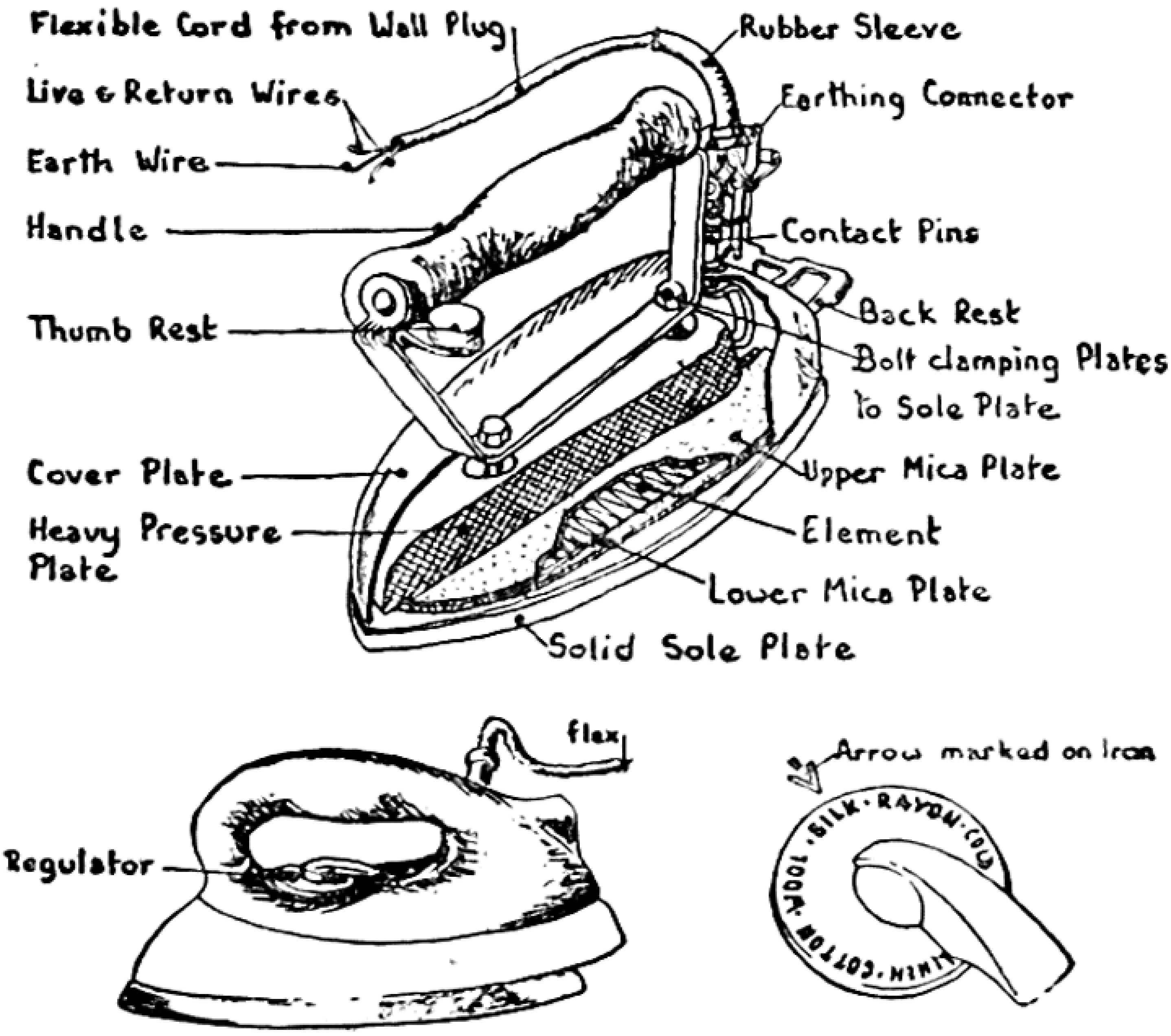


Fig. 20. Electric Irons. The one below has an automatic heat regulator shown on the right.

Below the element is a solid sole plate of iron with a bright chromium under-surface. The pressure plate, giving weight to the iron, is below the cover plate which is usually enamelled though some models have a porcelain surface. The handle is of bakelite or wood and there is a thumb rest.

The loading will vary according to the type of iron, but is usually from 400 to 500 watts. Many models are fitted with automatic control and can be adjusted to cotton, linen, wool, silk and rayon. (See Fig. 20).

The steam iron is provided with a compartment for holding water which drips on to the heated sole plate; the steam formed is released through vents in the under side of the plate and directed on to the material being ironed.

A domestic table-model calender for ironing sheets and household linen is now on the market and is useful in households where there is much washing.

Cleaning Appliances

The Vacuum-cleaner. The electric vacuum-cleaner has very largely superseded the use of brushes and beaters in those homes

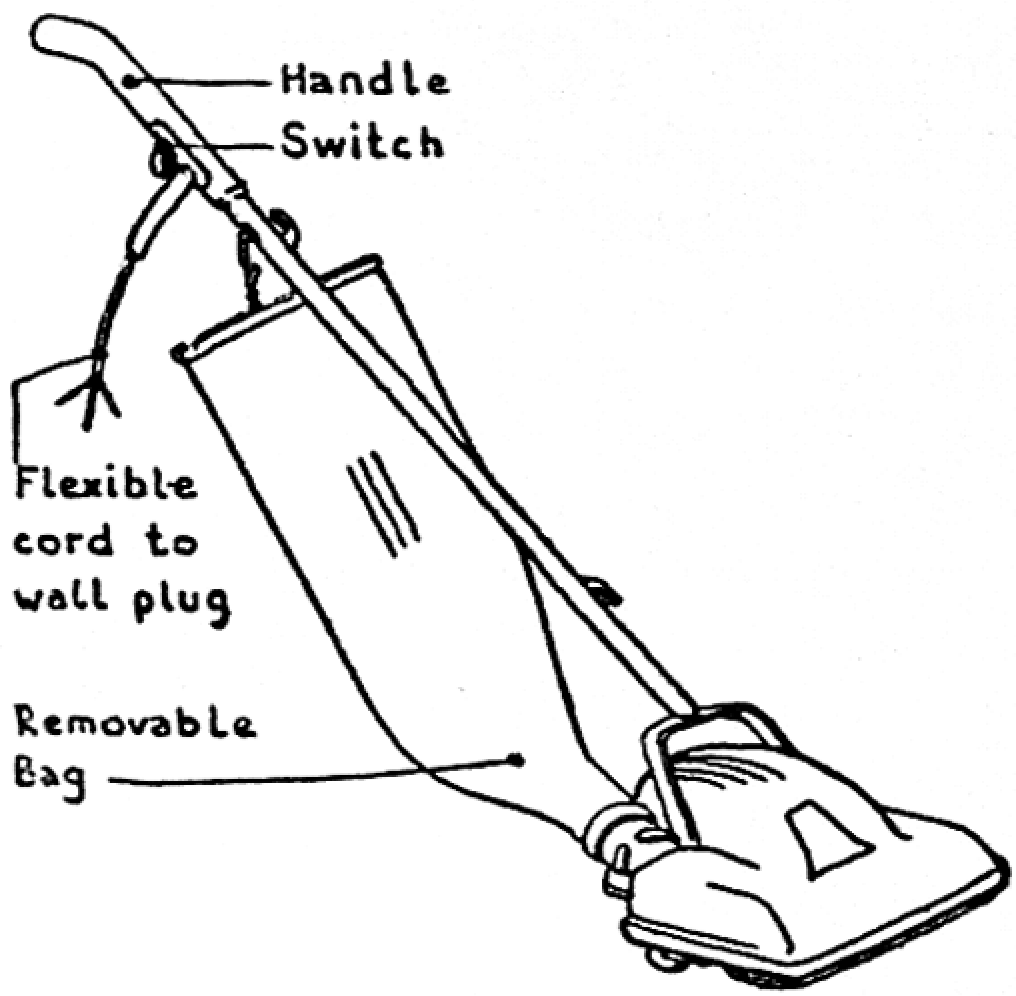


Fig. 21. An Electric Vacuum Cleaner

where there is a supply of electricity available, and where the initial cost of the cleaner can be afforded. The electric vacuum-cleaner is worked by a motor driving a fan at high speed which creates a suction, thus drawing in dust from carpets, crevices, floors and walls. The dust is sucked into a bag container, either through a flexible tube or directly from the bottom of the cleaner. The receiving bag is tightly attached and, while dust-proof, the air can escape through it. At frequent intervals the dust-bag must be emptied and the dust burnt.

A number of attachments have been devised to clean various kinds of surfaces; a small nozzle can be used to clean picture rails and the corners of the staircase, another can be used for upholstered furniture and curtains, and another for thrusting down the sides of chairs and couches; a further attachment is used for polished floors.

In those cleaners which do more than simply suck up the dust, revolving brushes and bars brush and beat the carpet, thus bringing dust through to the surface of the pile, whence it is sucked in.

The vacuum-cleaner has a plug which makes contact with the terminals in the appliance and has a long, well-insulated flex which can be wound round the handle of the cleaner when not in use. The other end of the flexible is attached to a plug, preferably a 3-pin plug, fitting into an earthed socket. There is a switch on the cleaner. With the brush type of vacuum, it is necessary to keep the brushes free from threads and hairs. Some makers service their own machines, which means that the oiling is done at regular intervals. The motor uses very little current, the usual loading being 150 to 250 watts or, approximately, $\frac{1}{4}$–$\frac{1}{6}$ unit per hour.

Electric floor-polishers. Special floor-polishers used for polishing parquet floors and highly polished boards can now be purchased, or attachments can be used on some vacuum-cleaners. The method saves much labour and effort and is to be recommended for large surfaces. The loading of the separate floor-polishers is much the same as for the vacuum-cleaner.

Carpet-sweepers. Carpet-sweepers are useful for taking dust, grit and cotton, etc., from carpets and, where there is no electricity available, they will keep carpets reasonably clean and in good condition. It is usual to use the vacuum-cleaner once or twice a week, and on the intermediate days to use a carpet-sweeper. The sweeper is in the form of a box with rubber-covered corners to protect the furniture. The four wheels are

on ball bearings and the brush underneath rotates rapidly and throws the dust into the box. Threads and hairs get twisted round the brush, and these must be removed to maintain its efficiency. The dust-box, fastened with a powerful spring, should be opened and the dust removed each time after use.

Brushes. Various types of fibre and bass brushes, made in different shapes and stiffness, are necessary in every house, even where the modern vacuum-cleaner is in use. Stiff, fibre brushes are used for carpets and rugs; horsehair is used for long brooms for sweeping floors and soft fibre for hearths, wooden surrounds, etc.

All brushes require care if they are to wear well. They should be washed in warm, soapy water at intervals and hung up when not in use. On no account should the bristle side be kept downwards against the floor when storing, or they will become bent and displaced.

Mops and Floor-polishers. Mops are made of soft cotton attached to a stale and are used for removing dust from floors and for maintaining the polished surface. Floor-polishers are also obtainable with a heavy, padded base, attached to a long handle, for rubbing and polishing wooden floors, linoleum, etc. If mops are impregnated with a special mop oil, the dust adheres to the mop and a polish is produced. A little paraffin sprinkled over a soft mop can be used in the same way. Mops can be purchased of a triangular shape for going into corners and with a hinged handle-joint so that they can be used under beds, etc.

Refrigerators

Information about Refrigerators will be found on p. 121 at the end of Chapter 15, 'Kitchen Planning and Equipment'.

17

Care of Rooms

ROOMS in regular use require daily care and cleaning. Special cleaning and care of the various types of furniture and fittings should be given weekly. Once or twice a year, the contents should be removed and a thorough cleaning given and, at intervals, decorating, such as paper-hanging, painting and distempering, is required.

The following are generally applicable routines for daily and periodic cleaning and care of different types of rooms:

Living-room, Dining-room or Lounge

Daily Cleaning

1. Remove hearth-rugs or other loose rugs.
2. Remove ashes and lay the fire, if a coal fire is used. Wash the hearth; shake cushions, covers, etc. Remove dead flowers, papers, etc.
3. If a square of fitted carpet is in use, use a carpet-sweeper for removing crumbs and dirt.
4. Sweep a polished or linoleum surround.
5. Replace rugs, cushions, covers.
6. Dust all the upper surfaces, working downwards.
7. Use a mop, sprinkled with a little paraffin or oil, to remove traces of dust from polished surround.
8. Replace flowers, etc.

Weekly Cleaning, in addition to the above

1. Remove ashes from grate if a coal fire is used. Clean any bars or metal surround to grate.

2. Wash the hearth, wipe lacquered fire irons, or polish if old-fashioned ones are used.

3. Use a vacuum-cleaner, working downwards from the picture rail, the curtains, upholstered furniture, to the floor, using the suitable attachments for each purpose. If no vacuum-cleaner is available, cover the furniture and sweep the floor using a stiff brush and sweeping with the pile of the carpet.

4. Clean windows and glass fittings and pictures.

5. Polish furniture, occasionally using furniture polish or a duster on which has been sprinkled a little oil; rubbing with a soft duster will remove fingermarks.

6. Dust all surfaces not already polished, including the light fittings and books.

7. Use the vacuum to collect dust from polished wood: clean with a good floor polish.

8. Replace cushions, covers, flowers, etc.

Spring Cleaning

1. Chimneys should be swept the day before spring cleaning. If possible, clean out cupboards, etc., beforehand. Remove ashes and cinders from fireplace.

2. Remove all curtains, cushions, covers for subsequent washing or, if to be dry cleaned, have these removed the previous day. Cover upholstered furniture with dust-sheets, after using vacuum. Remove books from bookcases, dusting each, or, alternatively, use the vacuum-cleaner before removing the books.

3. Remove any small pieces of furniture, such as tables, footstools, etc.

4. Take down pictures, dust and remove.

5. Use the vacuum cleaner on carpets. Fold up and remove. If possible, place the carpet on a lawn and clean with carpet soap or a soapless detergent. It may then be left in the sunshine to dry or hung over a clothes line.

6. Brush down walls and ceilings, or use the vacuum with attachments.

7. Sweep or vacuum the floor.

8. If painting or decorating is to be done, these should now be undertaken; otherwise, wash all paint work.

9. Wash the floor and allow to dry.

10. Replace the carpet, books and pictures, also furniture, cleaning each by the appropriate method.

11. After relaying the carpet, it may be sponged over with vinegar and water or carpet soap, if it has not been possible to do this outside.

12. Clean the windows and any glass fittings, including electric light fittings—if these are to be washed without removal, turn off the *main* switch.

13. Replace clean covers, curtains, etc.

Care and Cleaning of Bedrooms

Daily Cleaning

1. Immediately on rising, strip the bed, open windows wide and air the bedclothes in sunshine, if possible.

2. After breakfast re-make the bed. If the mattress is movable, it should be turned; the internal spring variety require turning only occasionally. Shake the pillows well, holding them by each corner in turn; place the under-blanket on top of the mattress and tuck in smoothly, then the under-sheet, which should also be tucked in on all sides. Replace the bolster and pillows. The upper sheet should then be spread over smoothly, and then the blankets. Tuck each in well at the foot and along each side. Fold the sheet down over the blankets at the head. The coverlet is then placed evenly over all. An eiderdown, if used, may be placed either above or below the coverlet. Night clothes, after airing, should be folded neatly and either placed in a nightdress or pyjama case or, if preferred, placed on the pillows beneath the coverlet.

3. If the floor is carpeted, use a carpet-sweeper to remove feathers, threads, etc. If the floor is linoleum-covered or has a surround of polished wood or linoleum, use a dry mop or one sprinkled with a little oil or paraffin. Particular care should be taken to remove dust from beneath the bed.

4. Remove all toilet articles from dressing tables, etc.

5. If there is a fitted basin in the room, wash the basin and surround, using a little cleaning powder if the water is hard. Wash and replace tumblers, etc.

6. Dust all surfaces, working downwards.

7. Care should be taken to hang up all garments in wardrobes and cupboards and to put away shoes, hats, etc., in their proper receptacles.

Weekly Cleaning

1. Shake mattresses and pillows well and dust the framework of the bed, if the mattress is a loose one. A vacuum-cleaner may be used with advantage for cleaning the mattress and bedstead, but this is not necessary every week.

2. Re-make the bed, changing the pillow cases and sheets as required.

3. Remove any loose rugs, cushions, dressing table covers, etc., and shake outside.

4. If there is no vacuum-cleaner available, use a carpet-sweeper or a brush for the floor and remove the dust. Then, after a short interval, dust all surfaces, working from above and downwards. Attention should be paid to the pictures, dusting the frames and the walls behind. Also picture rails and wainscots should not be forgotten. If a vacuum-cleaner is to be used, dust walls, picture rails, etc., first and then use the vacuum-cleaner on carpets or floors.

5. Furniture may be polished occasionally, and mirrors cleaned at intervals.

6. Silver toilet articles and ornaments should be polished each week.

7. Clean windows on the inside and wipe over light paintwork of window sills, etc., with a damp cloth.

8. Polished floors should be cleaned with furniture polish or beeswax and turpentine. A heavy polisher with a pad may be used, or an electrically-operated polisher is useful.

9. Replace all articles, rugs, covers, etc.

Spring Cleaning

If an electric vacuum-cleaner has been used weekly, it will not be quite such an exhausting piece of work. Drawers and cupboards should, if possible, be cleaned and relined with paper the day previous to the spring cleaning.

It is advisable to have the chimney cleaned a day or two before beginning the spring cleaning.

1. Open the windows and remove the curtains.

2. Remove bedclothes to an adjacent room, sending blankets, mattress covers to be washed, if possible.

3. Clean mattress and bedstead carefully with a vacuum-cleaner, or, if one is not available, brush with a fairly stiff brush. If the weather is fine, it is well to air the mattress outside in the sunshine, either over a clothes-line or on a mackintosh sheet on the ground. Cover the bedstead with a dust sheet, also cover any upholstered chairs, etc., with sheets.

4. Remove carpets and rugs. These may, with advantage, be laid on a grass plot or hung on a clothes-line.

5. Remove all covers, ornaments, toilet articles, books, etc.

6. Take down pictures, dust, and remove from room.

7. Brush down ceiling and walls, using the special attachment on the vacuum-cleaner, if available.

8. Remove any dust or ashes from the fire-grate and brush the back of the chimney.

9. Brush the floor and remove dust, or gather the dust by means of a vacuum-cleaner.

10. Wash the paintwork, using warm water and soap or some detergent. If very dirty, a cleaning powder may be used.

11. Wash or scrub the floor, according to the surface. A polished surface can be washed over with vinegar and water. This cleanses the floor without removing the polish.

12. Clean the windows, mirrors, etc.

13. When the floor is thoroughly dry, replace the carpets.

14. Polish furniture, using furniture polish, or wash with vinegar and water.

15. Re-make the bed.

16. Replace all small articles, pictures, books, etc., cleaning each before returning to the room.

17. Replace rugs, cushions, covers, etc.

When a room is to be redecorated, remove as much of the contents of the room as possible and cover furniture with dust sheets.

Care of Bathroom and Lavatory

Daily Cleaning

1. Towels and bath-mats should be hung to dry either on heated towel rails or in a draught in a warm position.

2. Soap, toilet articles, etc., should be placed in proper receptacles, and tumblers, etc., washed.

3. Wash the bath and wash-basin with hot water, using a slightly abrasive powder if necessary. Rinse and wipe dry with a cloth kept specially for the purpose.

4. If the bathroom and lavatory are in the same room, the water closet should be cleaned next, using a lavatory brush. Some proprietary cleansers are also disinfectants; suitable substances are chlorine bleaches, Lysol, etc. Wipe over all fittings with a special lavatory cloth.

5. Sweep the floor, wash over with warm water or polish according to the surface. Tiles should be wiped down. The window or ventilator should be kept open to air the room.

Care and Cleaning of Kitchen

Since the kitchen is rarely out of use, it is essential that it should be clean and tidy while cooking and other tasks are taking place.

Kitchen planning, as it has been explained, will arrange that the surface of all fittings is polished and smooth, and made of chromium, stainless steel, vitreous enamel or tiles, all of which can be quickly wiped over as each task is completed. Small pieces of equipment, utensils and food containers should be near at hand but out of sight as far as possible.

The order of daily work will, therefore, be as follows:

1. Water heaters should be switched on or domestic boilers attended to. (If storage cylinders are lagged, or if continuous burning fires are installed it is possible to begin the day with water that is already hot).
2. If there is an open fire it should be relaid, ashes removed and the hearth swept.
3. The floor should be swept and any mats shaken and replaced.
4. Polished surfaces should be dusted.
5. Breakfast dishes should be washed, and the sink and drainage boards cleaned.
6. According to the day of the week particular tasks should be undertaken, for example, washing; ironing; silver cleaning; baking, etc.
7. If a mid-day dinner or lunch is to be served cooking operations should be begun as soon as possible, and washing of cooking utensils and pans completed before the meal begins.
8. After the washing up of dinner dishes the cooker should be wiped over while still hot and tea towels and dish cloths washed out.

Weekly Cleaning

The order of weekly cleaning follows that of other rooms but in addition flues should be cleaned if a coal stove or domestic

water-heater is used; and gas or electric cookers should be taken to pieces and cleaned.

Pan shelves, cupboards and food containers should all be cleaned.

Any bright tins or cutlery should be polished.

The kitchen floor should be washed or polished; this may require attention several times a week.

Sinks and waste pipes should be cleaned and disinfected.

Spring Cleaning

1. Chimneys and flues should be swept, if possible the day before.

2. All portable equipment and food should be removed.

3. Curtains and covers should be removed and washed, if possible beforehand.

4. The walls should be brushed and washed down with hot soapy water if they are tiled or painted. Paint work of doors and window should also be washed.

5. The floor should be cleaned and polished according to the type of covering.

6. Furniture should be washed or polished.

7. Stoves and large appliances should receive attention, although if possible, some of this cleansing should be done in advance.

8. Electric light fittings should be washed, after turning off the main switch.

9. All portable articles should then be replaced, and curtains, covers and mats returned after cleaning.

18

Care & Cleaning of Metals, Leather Goods, China & Glass, Table Linen

Metal

A LARGE assortment of metal utensils and other articles is used in the home. A smooth, polished surface does not retain dust and grease as readily as a rough surface, for which reason metal should be rubbed and polished frequently.

Iron. Iron pans are used on gas cookers and coal fires, but their place has been largely taken by aluminium and enamelled iron. Care should be taken not to knock or drop cast-iron pans or kettles, as they can easily be cracked. Iron pans which are tinned inside should not be allowed to boil dry or be used for frying because the tin lining will melt and form lumps at the bottom of the pan. When the tin is removed, the pans will become rusty if left wet.

Steel is used for chopping-knives and cooking-forks. Stainless steel is used for many purposes in the house, including sink units, which are particularly clean and attractive, and for table knives. Stainless steel requires no other cleaning than washing with warm, soapy water and wiping dry. Ordinary steel knives should be cleaned with a cork dipped in brickdust or a proprietary powder. They can also be rubbed with emery paper, though this tends to wear them away quickly. Steel should not be allowed to remain wet or it will become rusty.

Brass and Copper. Brass and copper are not now much used for cooking utensils. Copper in moist conditions, forms on

the surface verdigris, a green substance which is a highly dangerous poison. It is therefore necessary that copper vessels should be carefully cleaned and highly polished before use. Washing with hot water and polishing with dry whiting will suffice.

Ornamental Brass and Copper. This may be lacquered, in which case the lacquer should not be removed with acid polishes. Soap and water and dry whiting can be used. When not lacquered, copper or brass trays, bowls, etc., may be cleaned with lemon and salt or vinegar and salt, or they may be cleaned with commercial metal polish.

Aluminium. Aluminium pans and other cooking vessels should be cleaned with steel wool. A wire or nylon pan-scrubber may also be used for dirty pans. If aluminium pans become stained, some acid substance, such as apple peelings, rhubarb, etc., boiled in the pan will clean it. Dry whiting can be used for small aluminium utensils. On no account should soda be used for cleaning greasy aluminium utensils, for, in addition to turning the metal black, hydrogen is formed and the smooth surface destroyed.

Tin. Tinned plate is quickly affected by damp and by the use of soda; it loses its bright surface and the iron beneath becomes rusty and discoloured. For this reason, harsh abrasives and soda which will injure the surface should be avoided and care should be taken to dry tin utensils in a warm place before putting away. Whiting will keep the surface bright and smooth; it may be used dry or mixed to a paste with water. Proprietary metal polishes are not suitable for tin articles used for cooking.

Silver and Electro-plate. Silver is a soft metal and can be easily scratched, bent or dented by rough handling and abrasive substances. Washing in very hot, soapy water in a wooden bowl and immediate drying with a soft tea towel will keep silver bright from day to day, with an additional rub with a wash leather. Once a week, table silver requires further cleaning;

other silver articles require occasional cleaning, according to their use.

Plate powder, which is a mixture of jeweller's rouge and precipitated chalk, used either dry or mixed into a thin cream with water, is excellent for silver. Precipitated chalk or whiting, mixed with a few drops of ammonia or methylated spirit and some water to a paste, may also be used. Care should be taken not to allow cleaning powder to lodge in the ornamental chasings of silver dishes, between the prongs of forks, etc. A specially soft silver brush can be used for removing traces of powder. Soft dusters or wash leathers should be used for polishing.

Silver can also be cleaned by placing the articles in hot water containing a little soda and a sheet of aluminium (some housewives use milk-bottle tops for the purpose). Hydrogen sulphide is formed with the sulphur in the tarnish on silver. A gas (smelling of rotten eggs) is given off, and the silver is left clean. Various patented silver-cleaners make use of this method.

Electro-plate, which is a white metal with a coating of silver, must be handled with care; metal polish and abrasives should on no account be used. Clean as for silver.

Chromium. This, like stainless steel, merely requires washing in hot water, and it can be rubbed with dry whiting if it has been exposed to dirt or grease.

Leather

Leather should be preserved from damp or overdry conditions, from rubbing or fraying, or from abrasive substances, which will roughen the surface. It should be cleaned regularly with a good wax polish which will burnish the surface and protect it from injury. For dark-coloured leather goods, a polish containing a dye will help to maintain the colour.

There are various imitation leathers, including plastics, now obtainable. These can be sponged, if very dirty, with warm water and cleaned with furniture cream.

Boots and Shoes. Remove mud and dust from shoes as soon as possible. There is no advantage to be gained from leaving mud to dry on shoes before removing it. Damp footwear should be dried slowly and carefully in a warm and draughty position, but the leather should never be allowed to get hot, or it will crack and blister. When taken off shoes should be placed on shoe trees, which will keep them in good shape. If shoes are dry, they may be stuffed with paper for the same purpose. Clean with a good shoe polish made from wax containing the dye suitable to the colour of the shoes. Rub it lightly in with a soft, clean brush and polish with a further brush reserved for this purpose alone. A final rub with a velvet pad will improve the shine.

Patent leather should be cleaned with a shoe cream. When not in use, rub with vaseline to prevent the leather cracking.

Suède. Brush lightly with a fine, wire teazle brush to give a matt surface. Special *suède*-cleaner, in a liquid or solid form, may be rubbed on the leather and brushed off again.

White Leather. A special liquid cleaner can be painted on with a small brush.

White Canvas. Blanco, mixed with water to a thin cream, should be applied with a small brush or sponge.

Heavy boots can be cleaned with blacking, and well brushed to polish. Climbing boots or any that may be exposed to water or snow should be rubbed with dubbin to make them waterproof.

China and Glass

To prevent chipping and breaking china and earthenware, avoid placing several articles inside one another. Tumblers stacked in this manner will break very readily. Avoid pouring very hot or boiling water into anything other than earthenware. To anneal new china, that is to temper it so that it will not crack when heated, place it carefully in a small bath of cold water, or in the wash-boiler, and bring the water slowly to the boiling-point, then cool. China and glass should, if possible, be washed

in a pulp or wooden bowl, one article only at a time being placed in the bowl. The water used for washing up should be hot and a little soap power or detergent added to make a very slight lather; for delicate colours and gilt, a soapless detergent is the best. Turn the cups upside down to drain away the water, and the saucers and plates also. Wipe while still hot with a clean, soft tea towel.

Tea-stains on china should be rubbed with a little dry salt.

Cracked and chipped cups and plates are most unhygienic, as particles of food and germs may lodge in the crevices; also, cracked utensils may come to pieces when being washed or handled and cause serious accidents, for which reason it is not advisable to attempt to mend dishes which have to be washed. Ornamental china can be mended with colourless mending fluids and Seccotine can be used for articles of less value.

When washing dishes on a large scale and where there are two sinks or receptacles available, rinse in a second hot water and dry in racks without using a tea towel. Electric washing-up machines are useful, and some types of washing machines used for washing clothes may also be used as dish-washers.

Glass.—Glass is even more fragile than china. Hot water will cause uneven expansion and cracking. Glass will take a better polish if it is wiped immediately it leaves the warm water and rubbed with a lintless cloth to polish.

Glass bottles are easily stained. If they are infrequently used, a small quantity of dry salt sprinkled at the bottom will keep the glass from going green. If stained, place a few tea leaves at the bottom, add salt, soda and hot water, and shake well to dislodge the discoloration. Milk bottles should be rinsed out with cold water and washed with warm water and soda.

Methylated spirit may be used for rubbing window glass, or glazed pictures; sprinkle a little on a soft cloth and rub well. Newspaper will be found to polish glass effectively and will not leave lint on the glass, as does fabric. A wash leather is also useful for polishing glass.

Table Linen and Table Appointments

A well-appointed table is part of the art of gracious and civilised living and will add to the pleasure of well-cooked meals. It is usual to cover the dining table with a linen cloth, which can be trimmed with lace and embroidery for certain meals, or to lay individual places with table mats. In either case, the table requires protection from hot dishes; polished wood, and in particular French polish, shows grey and blistered marks if heat or water is applied. If a tablecloth is to be used, a shaped felt covering, fitted to the table, is frequently placed beneath it and, in addition, cork mats are placed below the cloth where each cover is laid. If table mats only are being laid, a cork or wooden mat is placed beneath the more ornamental linen mat. If water is spilt, it should be wiped up at once and a thick piece of paper placed beneath the cloth to prevent water soaking through. Cork mats should be washed at intervals, using warm water, soap and a soft brush. Starched and highly polished linen keeps clean longer than unstarched linen, and care in laundering, particularly in ironing, not only gives a better effect, but the linen requires changing less frequently. Coloured linen and bright rayon cloths have taken the place of the heavy, white damask which was universal years ago, and in some cases brightly checked cotton cloths—if well starched and ironed—are suitable for breakfast and supper cloths. Individual place mats give opportunity for decoration with lace and embroidery, and a natural or unbleached linen lends itself to this treatment. It is usual for table napkins to match the table-cloth or mats. The correct folding of a table-cloth in a screen fold of four for the cloth and a double screen fold of three for napkins facilitates the laying and putting away of these articles. (See Fig. 22.) Care should always be taken to place the folded linens quite straight along the length of the table and to fold the cloth along the same lines. For this reason, crumbs should be removed with a crumb brush

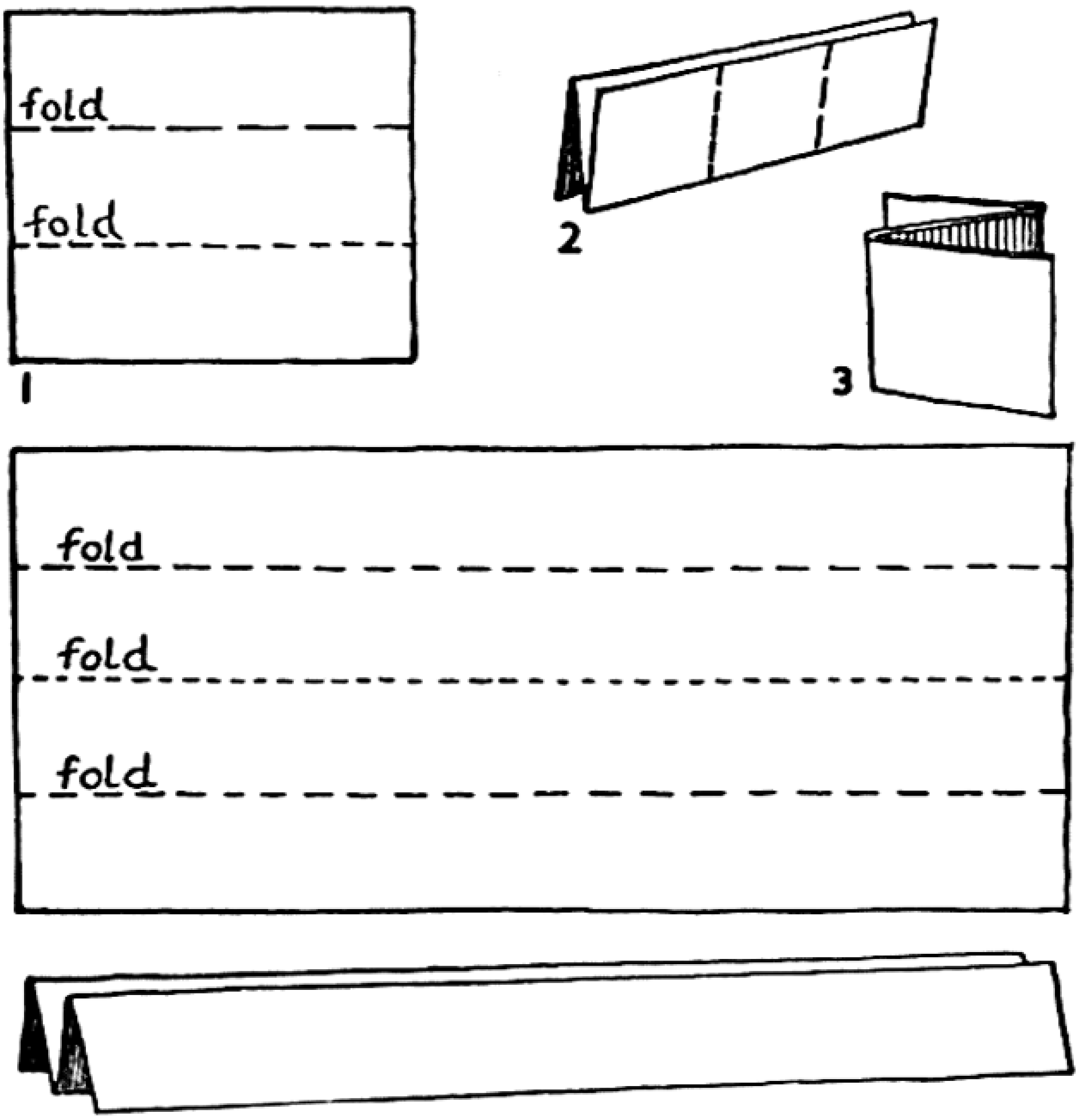


Fig. 22.

HOW TO FOLD (*above*) A NAPKIN and (*below*) A TABLECLOTH

or scoop and the cloth should not be crumpled up and shaken.

Table silver should, if used, be bright and shining. The modern tendency is not to use much table silver, except for spoons and forks, thus saving time in cleaning, and there are many glass and plastic articles, some very beautiful, to take their place. Table glass should be well polished; chipped and broken articles should not be used. Table service has also been made easier by the use of Pyrex or other glass ovenware, which serves the purpose of both cooking and serving dish.

Another pleasant modern revival is the use of finely-grained

and highly polished wood, such as sycamore, for platters, bowls, toast-racks, etc.

To Lay a Table. Collect the table linen, cutlery and glass required and place the cloth in position with the folded lines equally spaced from the edge of the table, using cork mats or individual linen mats, if preferred. Place the forks on the left-hand side, knives on the right, with the blade facing towards the centre. According to the number of courses, the knives and forks are arranged so that the first set required is on the outside. If soup is on the menu, the soup spoon is placed on the extreme right. *Hors d'œuvres* require a small knife and fork, or a fish knife and fork, which is frequently placed at the top of the cover. A fish knife and fork for a fish course are next in order, followed by a large knife and fork for the main course; a dessert spoon and fork are placed at the top, the handle of the fork to the left, the spoon above with the handle to the right. Some special courses, such as ices or savouries, may have the cutlery provided with the dish as it is served. Tumblers and glasses are placed at the right-hand side and a roll or bread on the left. Table napkins, if decoratively folded, can be placed in the middle of the cover; if in rings, they are placed on the left. Water-jugs are placed on the table, also salt and pepper servers and, if it is a 'family service', the carving knife and fork are placed at the head of the table and the tablespoons usually at the corners and at the head of the table.

A centrepiece of flowers or fruit is usual, and for parties individual small vases of flowers add to the gaiety of the table. In some cases, the service is from a side table, vegetables, etc., being handed at the left-hand side of the guests. On such occasions there is more room for decoration of the table.

19

Care of Furniture, Floors, Carpets, Bedding & Bed Linen

Furniture

The modern tendency is to have as much built-in furniture as possible, to save space and to save expense. There are, however, many articles which are necessarily portable, and with these simplicity of design combined with beauty of material is the ideal to be sought. The use of chromium, stainless steel, aluminium, coloured and plastics vitreous enamel has added to the variety of our choice. However, beautiful wood is difficult to supersede, and pieces of antique furniture of inlaid mahogany, dark oak and walnut are still unrivalled.

Care of Wooden Furniture. Wooden furniture, both new and antique, is open to attack by beetle. For this reason, furniture should be examined at intervals to see that there are no tell-tale holes. If these are found, there are special preparations which can be provided for syringing into the holes. The use of paraffin rubbed into the holes is also advocated. If valuable furniture is attacked by beetle, the advice of an expert cabinet-maker should be obtained. Furniture should be kept dry, but it should not be too much exposed to bright sunshine, which will raise blisters and dry the wood. Hot objects, such as plates and teapots, will make marks on polished surfaces and water, even if cold, spilt on French polish will raise blisters.

Rubbing and dusting will keep furniture clean from day to day. If furniture is dirty and sticky, it may be washed with a soft cloth or leather, wrung out in lukewarm water containing

vinegar (2 tablespoons to 1 pint), then wiped dry and polished with a soft duster. The vinegar produces a satisfactory polish. Occasionally, furniture should be cleaned with a very little good furniture cream; if too much is used, it will make the furniture sticky and give it a smeared effect.

Oak may be cleaned by rubbing lightly with a little linseed oil. Warm beer is an old-fashioned application which darkens the oak and gives a slight polish.

Walnut, Mahogany. Clean with a little furniture polish.

Lacquered Work. Rub lightly with warm flour and polish well by rubbing.

Inlaid Furniture. Clean in the usual way, but avoid raising the inlay or chipping it.

Stained or Marked Furniture. Rub lightly with linseed oil and continue using at frequent intervals till the stain is removed or lessened.

Upholstered Furniture. The use of a vacuum-cleaner will remove dust and keep the colour of the fabric bright. Care should be taken to avoid placing brightly coloured upholstery in the direct rays of strong sunlight. Covering with loose linen covers will help to preserve the upholstery from becoming rubbed and frayed.

To Revive Colour and Clean Fabric. Wring out a cloth tightly in vinegar and water (1 tablespoon to 1 pint) and wash the fabric lightly in one direction.

To Clean off Greasy Marks. Wring out a cloth tightly in ammonia and water (one teaspoon to a pint) and rub lightly in one direction, or use a soapless detergent and water.

Leather Furniture. Keep clean by dusting and clean occasionally with linseed oil and vinegar (2 parts of oil to 1 of vinegar). Furniture cream may also be used.

Wicker or Rush. Clean with the vacuum-cleaner and light rubbing. If very dirty, wash sparingly with salt and water. Tightly woven wicker on chairs may be cleaned and kept smooth with furniture polish, used very sparingly.

Enamelled or Painted Furniture. Clean by washing with warm, soapy water and polish well.

Care and Cleaning of Floors

Wooden Floors. If unpolished, are cleaned by scrubbing with soap and water. This however has the effect of softening and roughening the surface, causing splinters. It is therefore advisable to cover a wooden floor with linoleum or carpets or to stain and polish the wood.

To Stain Wood. If a dark colour is required, the wood may be stained with permanganate of potash dissolved in water, and applied with an old brush. The colouring will fade after a time and may rub off, but it can easily be replaced.

Another stain is made of linseed oil, turpentine and colouring matter, such as vandyke brown. Linseed oil applied regularly till the requisite colour is attained is an excellent method which helps to improve the wood.

Varnish. The use of varnishes containing colouring matter gives a brittle, high polish, which quickly deteriorates if walked on overmuch.

To Polish Floors (stained or not). Floor polish, made of wax and turpentine, should be used sparingly and well rubbed to remove the wax. If the floors are left slippery with polish, accidents may result. Alternatively, home-made polish of beeswax and turpentine dissolved together is much cheaper and quite as effective as other forms of polish. Polished floors that have become stained and over-darkened may be cleaned by either rubbing with steel wool and repolishing or by washing with warm vinegar and water.

Parquet floors are stained and polished in the same way. A very light stain—of a honey colour—which can be obtained by treating with boiled linseed oil alone, is particularly suitable.

Tiled floors should be washed with soap and water, but care must be taken to wash away the soap, which gives a clouded effect. Glazed tiles may be polished with furniture cream.

Stone floors may be washed with hot water and soda. For rough stone, a scouring agent, such as sand may be used with advantage.

Carpets and Other Floor Coverings

Carpets are either fitted to the shape of the room, which gives a warm and comfortable effect, or they may be in the form of a finished square, with a surround of polished wood or linoleum. If possible, carpets should have an underlay of felt, especially if the floors beneath are old or uneven. This prevents them from wearing out too quickly.

The types of carpet are (*a*) Axminster or Wilton, with a pile; (*b*) Brussels, with a looped thread through the canvas; (*c*) Turkey carpets.

The Cleaning of Carpets. Carpets should be cleaned, if possible, with an electric vacuum-cleaner once or twice a week; daily, a carpet sweeper or a soft brush can be used. Occasionally, carpet squares should be taken up and the position slightly changed, to avoid wearing in one place. When dirty, carpets should be shampooed, using a carpet soap, or soapless detergent, a soft brush, such as a nail brush, and warm water. The carpet is shampooed in sections or strips, care being taken to wash out the shampoo and finish each strip. Avoid soaking the carpet with water and dry quickly in a current of fresh air.

Stains on Carpets; Grease-stains. Use fullers earth sprinkled liberally over the stains. Leave for some time and brush out lightly. The treatment should be repeated till the stain is removed. If the stain is obstinate, make a paste with fullers earth and water.

Soot-stains. Sprinkle the stain lightly with salt or fullers earth and brush off lightly. Care must be taken not to rub loose soot further into the carpet.

Paint-stains. Rub lightly with turpentine, working towards the centre. Wash with warm water and soap.

Ink-stains. Remove with blotting paper if wet, and wash

with warm water and soap. If dry, wash away as much of the ink as possible. Apply a small quantity of Milton with a piece of rag and wash out quickly. Continue using the Milton and washing out till the stain is removed. Unless care is exercised, the colour of the carpet may be affected.

Linoleum. Linoleum and oilcloth should be carefully laid to avoid open joints, for they will allow dust to get beneath and, worse still, water which will cause these materials to rot. Water and soap are injurious to the fabric and scrubbing with a hard brush will roughen the surface. Linoleum should therefore only occasionally be washed, and it will be preserved and more readily cleaned in the same way as a polished wooden floor.

Matting. Coconut and fibre matting should, if possible, be taken up daily and shaken, and the floor beneath swept. Dust quickly passes through the coarse texture. If the matting is large or fixed in place, a vacuum-cleaner will remove the dust in the matting and that beneath it. When shaking matting, care should be taken not to break or tear the edges and the binding.

Care of Bedding

Sheets and pillow-cases should be frequently changed. It is usual to change the pillow-cases weekly and move the top sheet to the bottom, a clean sheet being used for the top. Blankets are washed occasionally, at least once a year. Bed-hangings, valances, etc., are old-fashioned and unhygienic.

To Clean Mattresses. A vacuum-cleaner with a special small attachment is invaluable for removing dust and fluff from any type of mattress. Loose mattresses of the hair or flock type should be covered with a calico cover, which protects the mattress ticking and can be washed. Feather beds are now considered out of date and unhygienic. Hair mattresses can be reupholstered at intervals, the hair being teased out and lightened before being placed in the ticking. Both wool

flock and hair mattresses can be converted to the more modern interior spring mattress.

All bedding should be constantly inspected for small holes and other injuries. If these are repaired at once, the bedding will last much longer and, if sheets and pillow-cases are sent to a laundry, any holes or tears should be repaired or drawn together before washing, or the articles may be ripped still further in the wash. Such repairs as turning the sides of worn sheets to the middle and darning thin places in blankets are all part of the duties of a good housewife.

20

Fabrics and Clothing

FABRICS may be divided into those that are derived (*a*) from animals: wool, alpaca, silk, fur, feathers, leather; (*b*) from vegetable sources: cotton, linen, jute, rayon, rubber; (*c*) from chemicals: nylon, plastic.

ANIMAL FABRICS

Animal fibres, such as silk and wool, are bad conductors of heat and, as they hold air entangled in the meshes of the fibres, this also makes them warm when used for clothing. Wool is absorbent and, to a lesser extent, silk; such fabrics absorb perspiration when worn next to the skin and prevent chills. Animal fibres shrink after continual washing and tend to become yellow, particularly if strong alkaline soaps are used; for this reason, they are not considered as durable as fabrics of vegetable origin. Both wool and silk are expensive—the tending and rearing of, in one case the sheep and the other the silkworm, calls for expert attention and the risk of loss.

Wool contains a large amount of oil in its composition and, after the fleece has been sheared from the sheep, it undergoes cleaning processes to rid the fibres of foreign substances and to remove some of the oil. The quality of wool depends on the type of sheep from which it is obtained, but climatic conditions, food, etc., have an effect, in addition to the breed. Wool is somewhat dark in colour and, to produce white fabric, it is bleached with peroxide of hydrogen. The fibres are combed, twisted and spun and finally woven into varying types of cloth; woollen yarn can also be knitted on knitting machines, to give a springy fabric suitable for underclothes. Coarse, harsh and

strong wool is used for carpets; other fibres are used for knitting wool, for blankets, and for tweeds and suiting.

Some typical woollen fabrics are flannel, serge, tweed, wool georgette and wool stockinette.

Silk is obtained from the fine filaments spun from the two spinnerettes in the head of the silkworm to form the cocoon. The thickness and quality of the fibres depend on the type of silkworm and its nurture, the temperature in which the caterpillar is bred, differences in spinning, and many other factors. The filaments are unwound from the cocoon, which is first thrown into hot water to kill the chrysalis before the moth can break through the covering fibres and emerge. So thin is the filament in the finest silks that a number must be spun together to make a thread. Natural silk is a pale cream colour; that from the wild moth is a dark shade, as in tussore or shantung.

Silk dyes readily and, with its glossy surface, it is one of the most beautiful of fabrics.

Leather is natural skin from which hair has been removed, and is excellent for retaining air within the clothing and resisting the passage of both wind and water. Soft leather, such as wash leather, is used for jackets and cardigans. Firmer leather is used for footwear.

Fur is the skin of a furry animal with the hair still attached. Not only does the hide resist the passage of wind and water, but the hairs retain in their depth a mass of insulating air and keep the body warm. It is only by this means that man can survive in Arctic conditions, when the temperature is much below zero.

Feathers share the same properties as fur, but since they are more delicate than hair, they are not very practicable as clothing.

Fabrics from Vegetable Sources

The vegetable fibres are good conductors of heat, and the fabric does not hold air within its structure as does wool; therefore, they do not retain the natural heat of the body. If,

however, a fluffy surface is formed, as in flannelette, or a cellular weave as in 'Aertex', air will be held within the fabric and the clothing will be warmer. Vegetable fibres are not so absorbent as animal fibres, and therefore cotton, linen and rayon are not usually worn next to the skin. Cotton and linen have both excellent washing and wearing properties and cotton, in particular, is one of the cheapest of fabrics.

Cotton. Cotton is obtained from the covering of the seeds of the cotton plant. After cleaning and combing, the thread is twisted and spun and then woven into cloth by either the spinning mule or the automatic loom.

Natural cotton cloth is yellow or grey in colour and can be bleached either by chemicals or by boiling and hanging in the sun. Cotton is readily dyed, and either the thread is dyed before weaving, making a fixed colour, as in gingham, or the cloth is woven and the pattern stamped on later, as in print, in which case the colour is apt to be loose. Cotton has a very wide range in types of cloth, from strong drill and sheeting to the finest organdie and muslin.

Linen is made from the fibres in the stem of the flax plant. These are firm and somewhat hard at the outset and are obtained by 'retting'—that is, removing the outer covering by soaking and then softening and separating the fibres. After treatment, the fibres are spun, twisted together and then woven into a strong, smooth and pliable cloth. Linen is one of the best wearing fabrics; it takes a polish when ironed which renders it dirt-resisting, but owing to the fact that its firm substance does not hold air, it is cool in wear and does not retain the natural heat of the body. It is therefore excellent for wear in hot climates, and is much used for household linen.

Rayon is not a natural vegetable fibre, but is obtained by chemical means from cellulose, which is a hardened form of starch. Viscose rayon, or artificial silk, is made by boiling cellulose from wood, paper or cotton with an acid which produces an acetate rayon or, alternatively, with an alkali. The

chemicals used reduce the cellulose to a pulp, which is forced through fine holes. It hardens and forms filaments resembling the filament produced by the silkworm. These filaments are twisted, spun and woven, as in any other fabric. Artificial silk is a good conductor of heat, resembling cotton in its properties. It can be produced much more cheaply than real silk, and in the beauty of its weave and colouring it can resemble real silk so nearly that it is difficult to distinguish at first sight between them. Artificial silk is used for all types of clothing and stockings, and has many uses for the home, including curtains and covers, tablecloths, etc.

Rubber is made from the rubber tree, but it is not strictly a fabric, in that it cannot be spun or woven. In making elastic fabrics, lengths of rubber are combined with cotton or silk threads. Rubber is non-absorbent and does not allow of evaporation or ventilation. It should not therefore, be worn next to the skin. Short lengths of rubber are inserted into belts, corsets, etc., and serve the purpose of making the garments flexible and able to stretch.

Nylon and Plastics

Nylon is a new fabric of chemical origin from which a filament that can be woven is made. It has not the properties of warmth and absorbency usually associated with clothing, but its fineness makes it suitable for undergarments, etc. It is quickly washed and dried, does not require ironing, and can, in its manufacture, be set into pleats which do not come out.

Plastics are also of chemical origin. They are not suitable for clothing other than mackintoshes, hoods, etc., as they are non-absorbent and do not allow of evaporation if worn next to the skin.

The Care of Clothes

Clothing can be divided into (*a*) clothing that can be readily changed and washed, such as underclothing or summer clothing;

(*b*) heavy fabrics and woollens that would shrink or pull out of place if washed, and require cleaning only at intervals.

All clothing should, if possible, be worn only for short periods of time. Washing fabrics should be laundered and garments used in rotation. Heavy woollen garments, frocks, suits and overcoats will repay being hung up for several days and rested after each time of wearing. One garment, if worn every day, will soon become shabby and show signs of wear, whereas two garments worn on alternate days will more than double their length of life. Garments should be carefully examined every time they are used for loose threads and buttons; buttonholes that show signs of wear, and fastenings and openings that are coming unstitched should be repaired; such careful usage will prolong the life of garments considerably.

Care should be taken to protect garments when working; stains and marks are difficult to remove and adequate protection will prevent their appearing. Watch should be kept for marks, and immediate removal is advisable. Methods of removing stains are given in Chapter 14. Grease-stains are the most detrimental to outer clothing, and the use of benzine and other proprietary grease solvents is frequently not entirely successful, since a ring is often left round the mark or a clean patch is noticeable where the stain has been. Petrol is a natural solvent, but it has such a low flash-point that dry cleaning in a bath of petrol should never be attempted in the home.

Careful brushing of heavy woollen fabrics will help to keep them clean, and the use of the vacuum-cleaner for overcoats and furs is helpful. Storing in closed cupboards and wardrobes also protects clothes from a dirty atmosphere. Garments will keep a better shape if hung in the position they are worn, on hangers.

Protection from Moths. Woollen fabrics and furs are always in danger from moths, especially in the summer months. The small clothes moth lays its eggs on wool or fur, choosing those in a dark cupboard or in a drawer, and any particular portion of the garment that is soiled or stained. The eggs

hatch into small grubs, and it is these that eat their way through the cloth. The grubs are extremely susceptible to sunlight and, if the garments are exposed to fresh air and sunshine at frequent intervals, there is less danger of their becoming moth-eaten.

If clothes are put away in a perfectly clean condition and are wrapped up in several layers of newspaper so that it is difficult for the moths to penetrate, they will be better protected than if hung, in a soiled condition, in a dark, airless cupboard. Moth-balls and other patent preparations are helpful in discouraging moths, but there is no absolute safeguard for valuable furs other than cold storage at a temperature in which the moth grubs cannot exist. It is possible to purchase moth-proof fabrics and research is continuing into making all woollen fabrics safe from moths.

Airing of Clothes. Washable garments should be carefully aired on a rack in a warm room or in an airing cupboard. Damp clothes are dangerous to health, and mildew stains will appear on cotton or linen articles that are left damp.

Pressing and Ironing. Cotton, linen and silk garments require careful ironing each time they are washed. Creased and rough garments collect dirt more quickly and give a very unkempt appearance.

Woollen frocks and suits are much improved in appearance and length of life if they are kept free from unwanted creases and pressed at intervals. Presses which keep the garments a good shape and preserve the crease are useful. Other woollen articles should be pressed with a warm iron on the wrong side, using a slightly damp cloth between the iron and the fabric. Special attention should be given to pleats and tucks and to the bottom hems, in order to give them a firm, crisp line at the edge.

21

Physiology

PHYSIOLOGY is the science of the vital functions of the body. These functions are performed by various systems, or groups of cells specially adapted for a particular function; there are many varieties of cells and tissues. The study of the structure of organic tissues is called histology. Anatomy is the study of the parts of the body. Hygiene is the science of the preservation of health, including sanitation: the avoidance, rather than the cure, of disease. In this chapter on physiology we shall make a rapid survey of some of the systems, saying a little about the organs involved. In Chapter 22 we shall have something to say on elementary hygiene.

Circulatory System

Materials necessary for the life of the cells of the body (such as the products of foodstuffs, oxygen and mineral compounds) are carried to the tissues by the *blood*; and waste substances (such as carbon dioxide, urea, and dead cells) are carried away by the blood for elimination by the lungs, kidneys, etc. The circulation of the blood, caused by the pump-like action of the heart, is thus a perpetual 'round' of delivery and collection.

Blood, which becomes sticky on exposure to the air and looks red to the naked eye, is made up of a watery fluid called plasma (very pale yellow, almost colourless) and little solid cells called corpuscles, some red, some white.

The plasma contains dissolved foodstuffs and minerals, such as common salt.

The red corpuscles are numerous and extremely small cells about one $\frac{8}{1000}$ in. in diameter. They are circular, jelly-like discs

with slightly depressed centres, and contain hæmoglobin, a compound of protein and iron. Hæmoglobin has an affinity for oxygen, and absorbs it from the air breathed into the lungs, forming with it a loose compound, oxyhæmoglobin, carbon dioxide being given up at the same time. When the blood reaches the finest thin-walled tubes or 'vessels' (called capillaries) the oxyhæmoglobin (which is scarlet in colour) gives up oxygen, reverting to hæmoglobin (which is a deep purplish red). The oxygen passes into the tissues dissolved in plasma, which, together with the white corpuscles, seeps through the capillary walls, forming lymph. The oxygen unites with carbon from foodstuffs to form carbon dioxide, heat being given off. In other words, combustion takes place; but this is slow combustion, and the heat given off (which is the body's source of energy for all its activities) is not, of course, fierce, flaming heat such as is produced when the carbon in coal unites with oxygen from the air. The waste products of combustion, the carbon dioxide, which is dissolved in the plasma, is carried to the heart and then to the lungs, where it is breathed out.

The white corpuscles are larger than the red and much less numerous: the proportion is about one white to 500 red. They are jelly-like cells with a nucleus, and some of them change their shapes constantly; they can leave the blood vessels together with plasma, so forming lymph. This lymph is a colourless liquid surrounding the tissues and contained in a series of very small, very thin-walled vessels called lymphatics, forming another system, the lymphatic system, which plays an important part in the delivery of food and oxygen to and the removal of waste from the tissues. The function of the white corpuscles in both lymph and blood is that of defending the body from invading bacteria—by engulfing the invader, and thus preventing the spread of infection. If the bacteria are numerous (and they increase with great rapidity), the white corpuscles may be overcome and the disease will take hold of

the system. The white corpuscles have the additional faculty of manufacturing anti-toxins, which act on the poisons thrown out by the invader and also kill the bacteria, preventing the further spread of the disease. Once manufactured, the anti-toxin gives whole or partial immunity from that particular disease in the future; and this power of the white corpuscles is made use of in inoculation and vaccination, a mild form of a disease being deliberately communicated so that the anti-toxins which give protection from the more violent form may be created.

The plasma, also, has several important functions. It is the plasma that distributes digested food materials and carries waste products to the excretory organs. Secretions of glands, such as the thyroid, which control the activity of the tissues, are also transported in this way. The heat produced when oxygen combines with food in the cells is taken all over the body; and anti-toxins are likewise distributed.

When a blood vessel is severed, and the blood is exposed to air, a substance dissolved in the blood, fibrogen, is converted into a tangled meshwork of solid fibres which trap the corpuscles and forms a clot which hardens and effectively seals the broken tubes.

Summing up, we can say that the blood is a transport system concerned with the processes of nutrition, energy-production, excretion, temperature control and general body activity. It is also a means of defence against invading germs.

The Heart, which supplies the motive power for the circulation of the blood, is a hollow, muscular organ situated in the middle of the chest (or thorax), with the apex, or point, turned to the left. It is covered with a membrane, the pericardium, which is a kind of bag. This also helps to keep the heart in position among the other chest organs. The muscular walls of the heart are thinner at the wide top portion and thicker at the apex, especially on the left side. (See Fig. 23.)

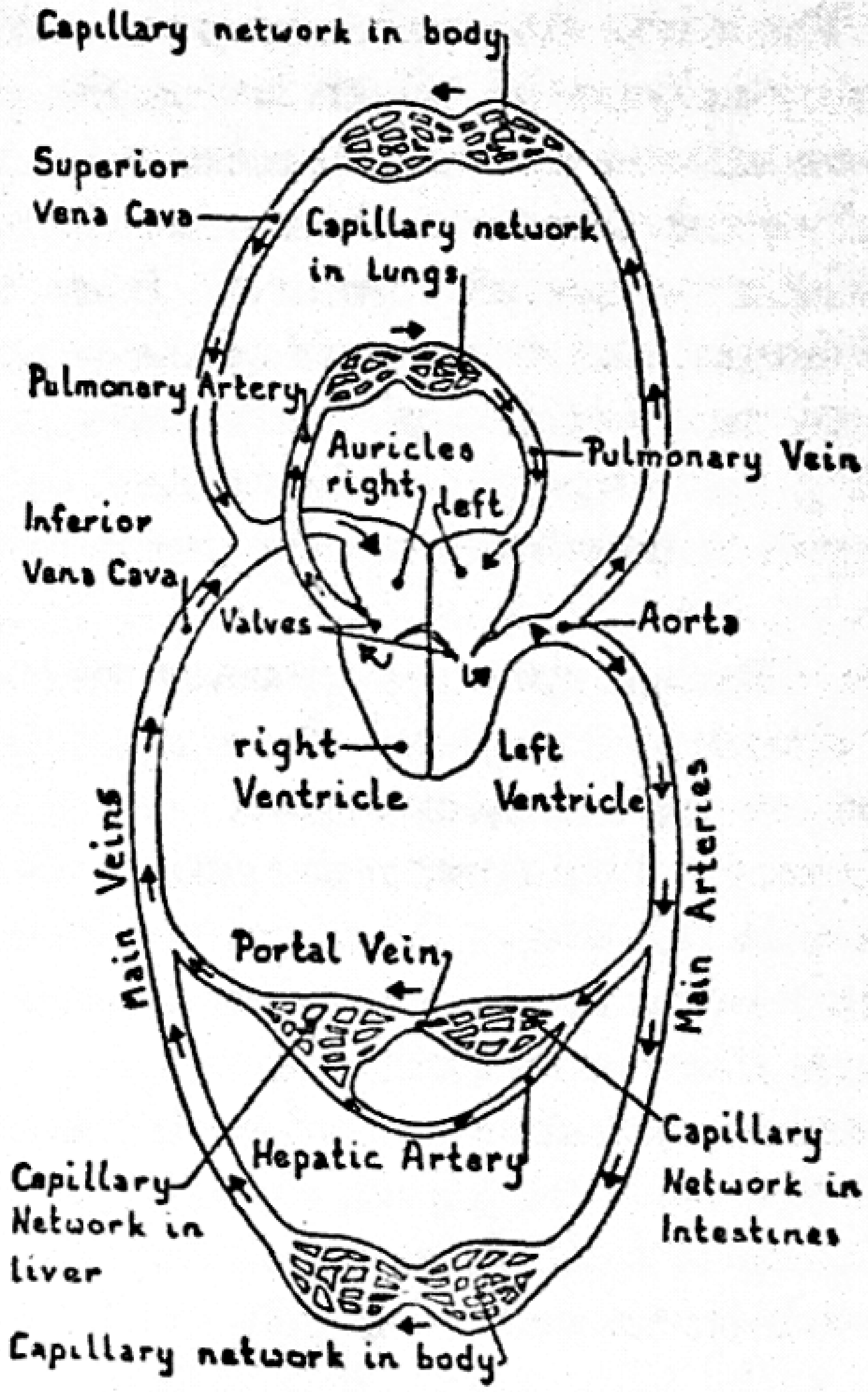


Fig. 23. THE CIRCULATORY SYSTEM

The inner cavity is divided into two chambers vertically, each chamber being further divided into an upper and lower portion by movable valves attached by cords of strong tissue to its side. The two top chambers are the right and left auricles; the two bottom, the right and left ventricles; and from each chamber lead main blood vessels.

The heart beats on an average 72 times a minute, its rate increasing during exercise and decreasing during rest and sleep. The complete movement begins with a smaller beat when, the two auricles being full of blood, the muscles of the chambers contract, forcing the blood through the valves into

the ventricles. As the ventricles fill the blood forces the valves upwards, so that the opening between auricle and ventricle is closed and the blood is prevented from flowing backwards. The muscles of the ventricles contract, forcing the blood out into the arteries, from the left side into the large main artery, the aorta, and from the right into the pulmonary artery which carries blood requiring oxygenating into the lungs; this forms the second and larger beat. These two beats from the heart, which can be heard by the ear or stethoscope placed on the chest wall, are usually described as 'lup-dub'. There is then a brief pause while the auricles fill with blood again from the veins.

Blood Vessels. Blood is contained in tubes. The arteries, flowing from the ventricles, are the vessels which carry blood away from the heart. Their walls consist of an outer fibrous coating, a layer of muscular fibres and an inner coating of smooth membrane. As the blood is forced from the heart, the larger arteries assist the flow by muscular contraction of their walls, previously stretched by blood forced into them. This jerking movement, corresponding to the contraction of the ventricles, is felt as a pulse where the artery comes near the surface. When the blood leaves the aorta it is taken by various branches to the upper limbs and the head and neck. A deeply buried main artery conveys blood to the trunk and to the lower limbs. The further the arteries are from the heart, the smaller they are (the 'arterial tree'), until they become narrow tubes known as arterioles.

Leaving these arterioles, the blood runs through a fine meshwork of tubes, the capillaries, the walls of which are one cell only in thickness, and into and from which soluble substances, oxygen and white corpuscles, can readily pass. The capillaries connect the arteries which take the blood from the heart with the veins that take it back. (See Fig. 23.)

The blood then travels through small veins which join with others forming wider ones until eventually two large veins enter

the heart. Veins have thinner walls than arteries, with less elastic and muscular tissue. The blood flows through them without the jerk which characterises its flow through the arteries, and there is no pulse. The wall of the vein is provided with small valves or pockets which prevent the blood from flowing backwards.

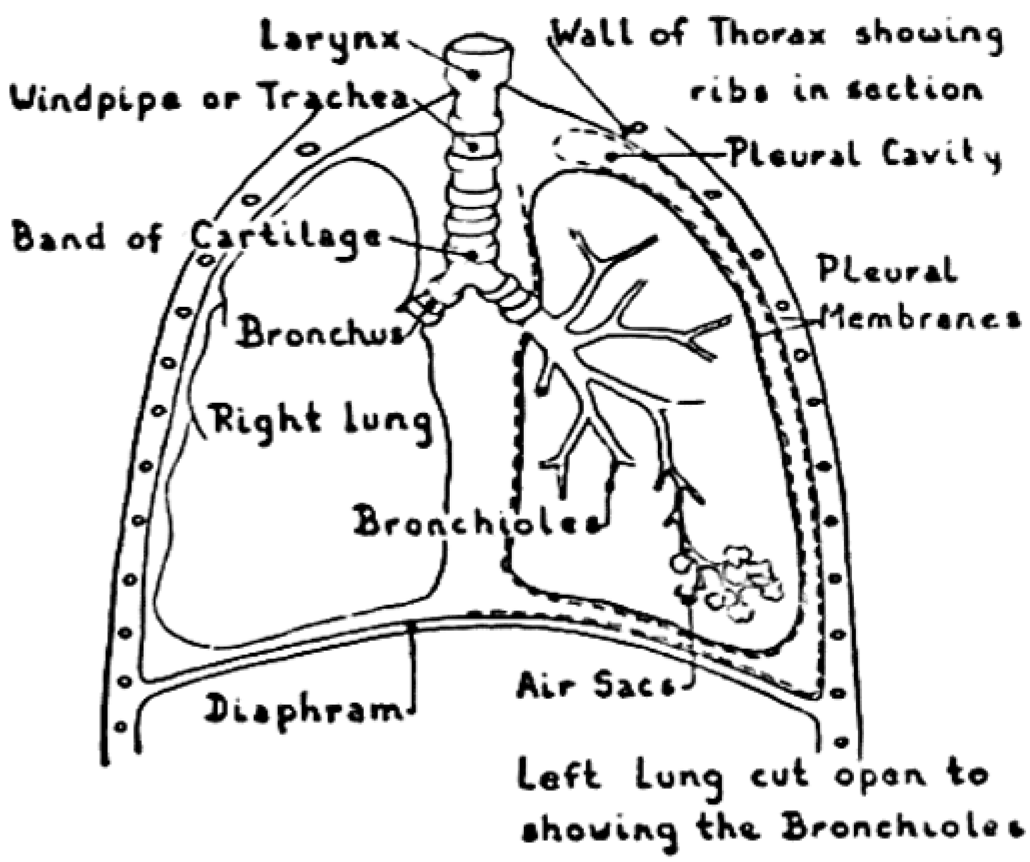
It is the bright red, oxygenated blood containing oxy-haemoglobin that enters the left auricle, passes into the left ventricle, into the aorta and through the narrowing arteries into the capillaries, and thus into the tissues where the exchange of oxygen for carbon dioxide takes place. It is the dark, de-oxygenated, purplish-red blood which flows back from capillaries to widening veins and into the right auricle of the heart, to be pumped into the right ventricle, leaving the heart by the pulmonary artery to be carried to the lungs, where fresh oxygen is absorbed and carbon dioxide given up, and whence the oxygenated blood flows through veins to the left auricle, completing the cycle. Thus while the blood from the right side of the heart is only propelled through the lungs (the pulmonary circulation), that from the left side has to be sent through the whole body (the general circulation) which accounts for the relative thickness of the walls of the left side of the heart. Note, too, that it is the bright, oxygenated blood that flows through the left side, the darker, deoxygenated blood through the right.

Respiratory System

Respiration, or breathing, comprises the inspiration, or breathing in, of air containing the oxygen which is absorbed in the blood and carried to the tissues, and the expiration of air containing a large percentage of carbon dioxide.

The main organs concerned in respiration are in the nasal passage; (sometimes) the mouth; the pharynx; the larynx; the trachea, or windpipe; and the bronchial tubes and bronchioles in the structure of the lungs. (See Fig. 24.)

During its passage through the nose, the air is cleaned and



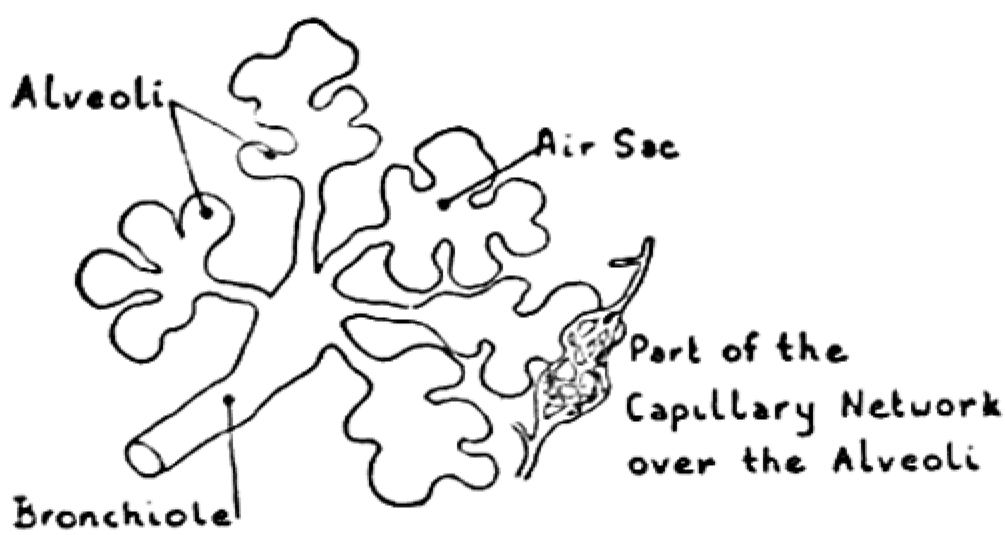


Fig. 24. THE LUNGS AND BRONCHIAL TUBES
Below: bronchiole, air sacs and capillary network.

warmed and passes over special cells connected with fibres of the olfactory nerve, which is the sensory nerve of smell. Air passes down into the windpipe, past the epiglottis, which is a thin structure acting as a lid by which the glottis is closed when food or water is swallowed.

The *trachea* is a tube about 4½ in. long. It is partially encircled by rings of cartilage which keep its muscular walls from collapsing. It is lined by mucous membrane with little hairs on the inside which protect the tube from dust and by

their movement eject mucous. It divides into two forks called bronchi, one of which enters each lung.

The *lungs* fill two-thirds of the space in the thorax, and are held loosely in place by a double membrane, the pleura—which lines the thorax and covers the lungs. They are pink in colour—though this may not be strictly true of the lungs of town-dwellers in the foggy season. They consist of a mass of elastic tissues threaded with fine air tubes and blood vessels.

Air passes through the bronchial tubes, which divide and subdivide into finer tubes until they become microscopic air-passages in the lung tissue and terminate in small chambers called air-sacs. The result of the folding of the lung tissue into this honeycomb of air-sacs is that a large surface is packed into a relatively small space; also the lungs are, of course, very light in weight for their bulk.

Closely surrounding the pockets (alveoli) in the walls of the air sacs is the meshwork of capillaries, carrying blood charged with carbon dioxide from the heart by way of the pulmonary artery. Through the lungs this blood passes, exchanging its carbon dioxide for oxygen from the air in the air sacs. Out of the lungs flows the now oxygenated blood by way of the pulmonary vein; while the carbon dioxide passes into the air sacs, the bronchioles and bronchial tubes, to be breathed out through the nose and mouth.

The movement of air into the lungs and its expulsion are carried out by the movements of the diaphragm, which arches upwards when used air is breathed out, and moves downwards during inspiration; at the same time the muscles connecting the ribs—the intercostal muscles—relax, pressing downwards on the lungs, and then contract, raising the ribs. During inspiration the space within the chest wall is greater and the pressure less, and air enters the lungs; during expiration the space is less and the lungs become smaller—the used air being pressed out.

When air is expelled from the lungs part always remains in

the air sacs as 'residual' air, in contrast to the 'tidal' air which is drawn in or expelled with each breath. The residual air mixes gradually with the tidal, so that no air remains static in the lungs for long.

Digestive System

Food passes through a very long tube (about 28 ft.) called the alimentary canal, which extends from the mouth to the rectum, most of its length being contained in the abdominal cavity, especially in the coil-like tubes of the intestines. Only the unused residue of unwanted food material reaches the rectum, to be evacuated from the body through the anus. (See Fig. 26.)

Food consists of complex substances which can be used by the body for providing heat and energy; for replacing and repairing cells and tissues; also, in the young, for building up the new cells and tissues needed for growth.

It is necessary for these substances to be broken up into simpler substances. Also, they must be rendered soluble and capable of absorption into the bloodstream. The particular substances found in foodstuffs are (*a*) the carbohydrates, starch and sugar, which must be changed into the form of sugar called glucose (or grape-sugar); (*b*) fats, which must be emulsified and eventually changed into fatty acid, soap and glycerine; (*c*) protein, which must be changed into peptones and then into amino-acids.

The organs concerned in digestion are:

1. The mouth, with the tongue, teeth and salivary glands.
2. The gullet or oesophagus leading to the stomach, with the glands which secrete digestive juices.
3. The small intestine, together with the large glands, the liver and the pancreas, all of which secrete digestive fluids.
4. The large intestine into which indigestible food and waste substances are passed and absorption of water takes place.

Digestion in the Mouth. Food, when taken into the mouth, is torn and broken up by the action of the teeth, with the help

of the tongue and the muscles of the cheeks and throat; it is also mixed with saliva.

Teeth consist of dentine, a hard calcified tissue which surrounds a hollow cavity containing soft pulp made up of nerves and blood vessels. The crown (the exposed upper part) of each tooth has an outer covering of enamel, which ceases at the point where the tooth is cemented into the gum of the upper or lower jaw. (See Fig. 25.)

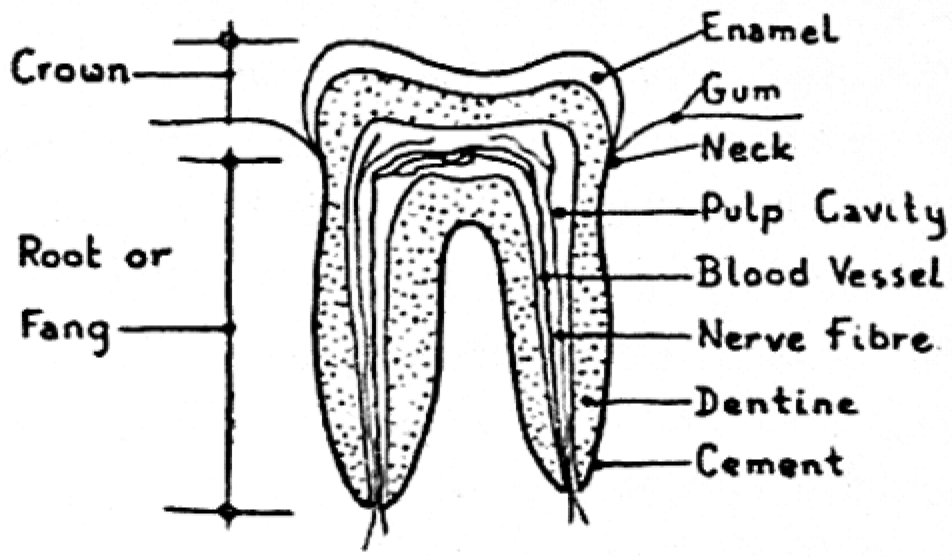


Fig. 25. The Structure of the Teeth

There are several distinct types of teeth: the incisors or cutting teeth; the canines or tearing teeth; the bicuspids with two points on the surface; and the molars, or chewing teeth, at the back of the mouth. The incisors and canines have one fang or root, the bicuspids two, and the molars in the upper jaw have three, while those in the lower jaw have two only.

Saliva is secreted by three pairs of large glands, those below the ears, those below the tongue, and those in the lower jaw; there are also small glands embedded in the tongue and cheeks. The saliva is alkaline and contains the ferment ptyaline; it is always present in the mouth to moisten the lips and to help speech, but it flows more readily just before and during a meal.

The ptyaline acts upon starch, turning it into dextrose, a form of sugar, but it has no actions upon fats or proteins. Fats, however, are melted, and proteins dissolved and broken up by the warmth and movement of mastication.

When food is sufficiently chewed it is passed to the back of the

throat as a 'bolus', and by a muscular contraction of the throat it is pushed over the top of the windpipe and epiglottis and into the gullet. The food is moved slowly down the gullet by a wave-like action of muscles in the walls of the gullet or oesophagus, and enters the stomach.

Digestion in the Stomach. The stomach is a bag-like expansion of the alimentary canal. It has a strong fibrous and muscular coating, and is plentifully supplied with glands. The stomach is pear-shaped; the bulging wider portion is to the left, immediately below the diaphragm and the heart, and is known as the cardiac end. It is towards the left of this cardiac end that the oesophagus enters the stomach. The narrow end which lies to the right is called the pyloric end.

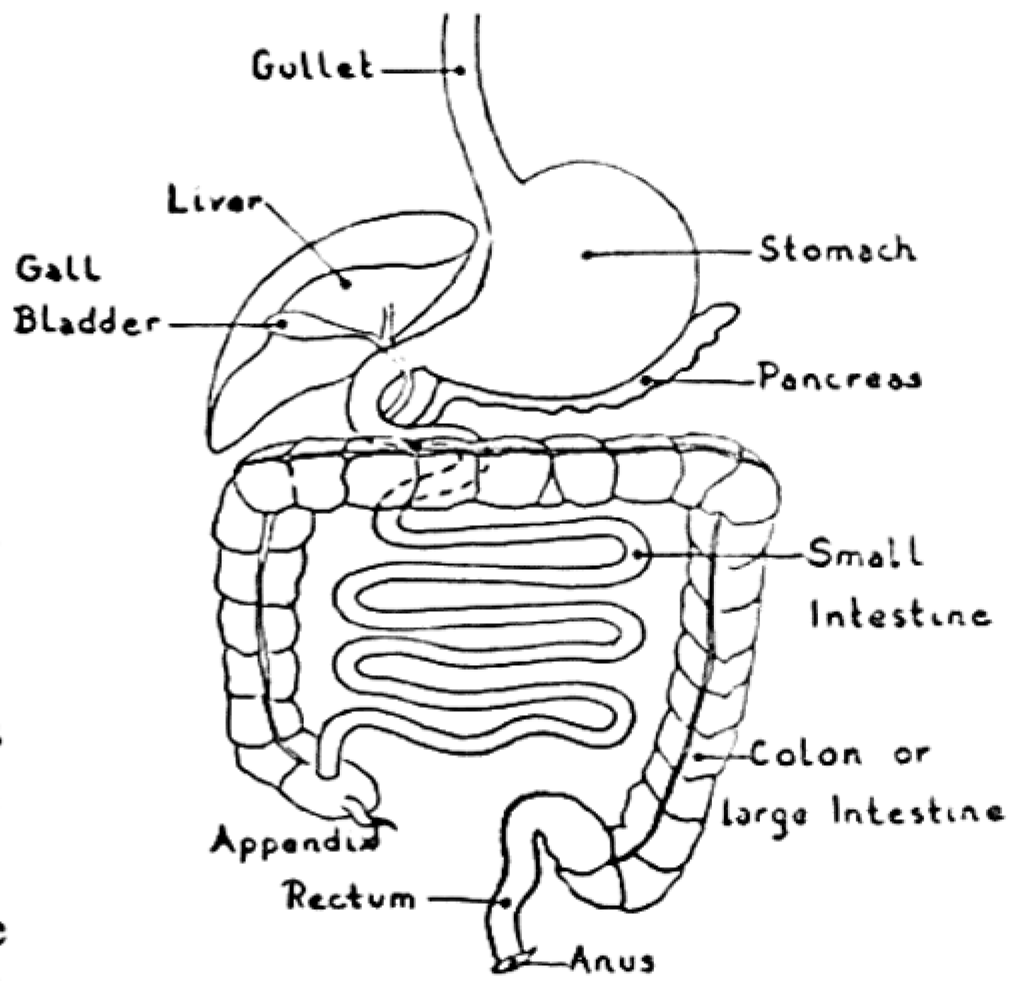


Fig. 26. THE ALIMENTARY CANAL, showing position of stomach, liver, etc.

Owing to the bulge of the stomach, and to the fact that it can be distended, it is possible for the food sent into it down the narrow oesophagus to be retained for some time. The exit at the narrow pyloric end can be closed by a sphincter, and partly digested food is only released a little at a time. ('Sphincter' is the word for a muscle guarding an opening; 'pylorus' means 'gate-keeper'.) Digestion in the mouth is of only short duration, but in the stomach it may continue for several hours. The secretion of the tubular glands in the stomach wall is called gastric juice, and it contains a powerful enzyme, pepsin. Hydrochloric acid necessary for the functioning of the pepsin is also present, and this inactivates the ptyalin brought down from the mouth, so

that when all the food has been mixed with the gastric juice no further carbohydrate digestion occurs until the next part of the alimentary canal is reached. Also present in gastric juice is the enzyme rennin, which clots the milk proteins, ensuring that they remain longer in the stomach to be exposed to the action of the pepsin, which converts proteins into soluble peptones.

During the few hours the food remains in the stomach the muscular movement churns it about until it is reduced to a thick fluid resembling pea soup and known as chyme. Meanwhile a very little absorption—of water, sugar and peptones—takes place. When the contents of the stomach are sufficiently digested the acidity of the chyme relaxes the sphincter, and the food passes as chyme through the pyloric opening of the stomach into the duodenum, the curved tube about 10 in. long which forms the first part of the small intestine.

Digestion in the Small Intestine. The small intestine is a tube —about 20 ft. long—coiled to fill the major part of the abdomen, with walls ridged, folded and pitted with glands which secrete intestinal juices.

A duct enters the small intestine at the inner curve of the duodenum, bringing bile from the liver and pancreatic juice from the pancreas.

The liver, the largest gland in the body, is situated at the right of the abdomen; arteries and veins join the liver, and the bile duct leaves it, at a fissure on its under surface which divides it into two main lobes and is called the portal fissure. It is supplied both with arterial blood (brought by the hepatic artery) and with blood bringing digested food from the stomach and intestines (which enters by the portal vein), and besides the manufacture of bile has other important digestive functions, some of which will be mentioned later.

The pancreas, or sweetbread, is a gland which lies below and behind the stomach, in the bend of the duodenum. The ducts conveying the secretion from the pancreas and the liver unite before entering the duodenum.

Bile is a bitter alkaline fluid of a reddish brown colour, which assists in the digestion of all types of food, but more particularly fats, and has an antiseptic action upon the bowels.

The pancreatic juice contains three enzymes: trypsin, which acts on proteins and peptones; lipase (or steapsin) which acts on fats; and amylopsin, which acts on starch. The intestinal juice also contains enzymes. The combined effect of these two sets of enzymes and of the bile is to complete the digestive process of changing carbohydrates into glucose, proteins into amino-acids and fats into fatty acid, soap and glycerine.

When the three types of food have undergone these changes they are soluble, and are capable of being absorbed through the wall of the intestines into the blood.

Absorption of Food. The walls of the small intestine are lined with a fur-like pile (rather like tripe), the membrane being provided with projections resembling minute fingers. Each projection is known as a villus, the number of villi in the whole tract being immense. The covering membrane of the villus has the property of selecting and absorbing the food substances as they pass over its surface. Inside the villus there are minute blood capillaries and a centrally situated tube, called a lacteal, which leads into a tiny lymphatic vessel. The digested fats, in the form of fatty acids, glycerine and soaps, are collected in the lacteal and sent through the lymphatic vessels and on into the blood stream. The blood vessels in the villus absorb the amino-acids and glucose, and they pass with the blood through the portal vein into the liver.

Assimilation of Food. The blood, it will be remembered, distributes the nutriment to the cells and tissues of the body. Amino-acids, glucose and fats are subject to further changes before being used. For instance, the liver and the muscles convert some of the glucose which is not immediately required into glycogen. When the muscles need extra glucose, glycogen from the liver store is re-converted and sent to them as glucose. Some of the amino-acids are changed into blood proteins and

body proteins for the rebuilding and restoring of cells and tissues. More amino-acids than are required by the body are absorbed, and the excess, which would prove harmful if retained, is converted into relatively harmless urea in the liver. Fat is used for producing heat and energy, and is also stored in tissues all over the body.

The storage and distribution of digested foodstuffs and the uses to which they are put is a matter of balance and delicate adjustments. These processes together with the absorption and assimilation of food and all the chemical changes which go on in the cells of the body are known as metabolism; and the rate of metabolism varies in individuals.

Excretory System

The excretory system gets rid of waste substances and impurities which have at some time been part of the cells of the body. Carbon dioxide set free during energy production is excreted by the lungs. Urea from excess amino-acids and broken-down cell proteins leave the body via the kidneys, together with certain mineral salts. Excess water is excreted as vapour by the lungs and in liquid form by the kidneys and skin.

The *kidneys* are two small organs situated at the back of the abdomen just above the waist. They are reddish brown in colour, and covered by a membraneous capsule of connective tissue. (Connective tissue is tissue that holds together the other tissues of the body.) At the inner curve of each kidney there enters a renal artery and leaves a renal vein. ('Renal' is derived from *renes*, or reins, the old name for kidneys, from the Greek verb meaning 'to flow'.) A narrow tube called the ureter passes from each kidney to the bladder; the two ureters open out in the kidneys into funnel-shaped chambers. The substance of a kidney is divided into an outer portion in which there are minute branches of the renal artery, and an inner portion made up of fine tubules, whose cells separate urea, uric acid, mineral salts, and water, from the blood. These form the

fluid urine, which passes slowly along the tubules into the funnel or pelvis of the kidney and thence to the ureter and so to the bladder, where it is stored for a time. When the bladder is full the muscle fibres of its sphincter relax and the urine is expelled—after early childhood, subject to voluntary control. (See Fig. 27.)

The *skin* (which acts as a covering to the tissues, blood vessels and nerve endings, and as an organ of touch) is concerned with the regulation of the body temperature, and is also an excretory organ.

The skin consists of two layers: the epidermis or false skin, which is made up of flattened layers of cells, the outer cells being of a hardened or horny nature; and the dermis or deep layer, containing blood vessels, connective tissue, fat cells, and nerve endings, or touch corpuscles. The dermis throws up into the epidermis projections called papillae, which are seen as ridges on the fingers and feet. Some of these papillae contain the touch corpuscles which are the endings of the nerve fibres.

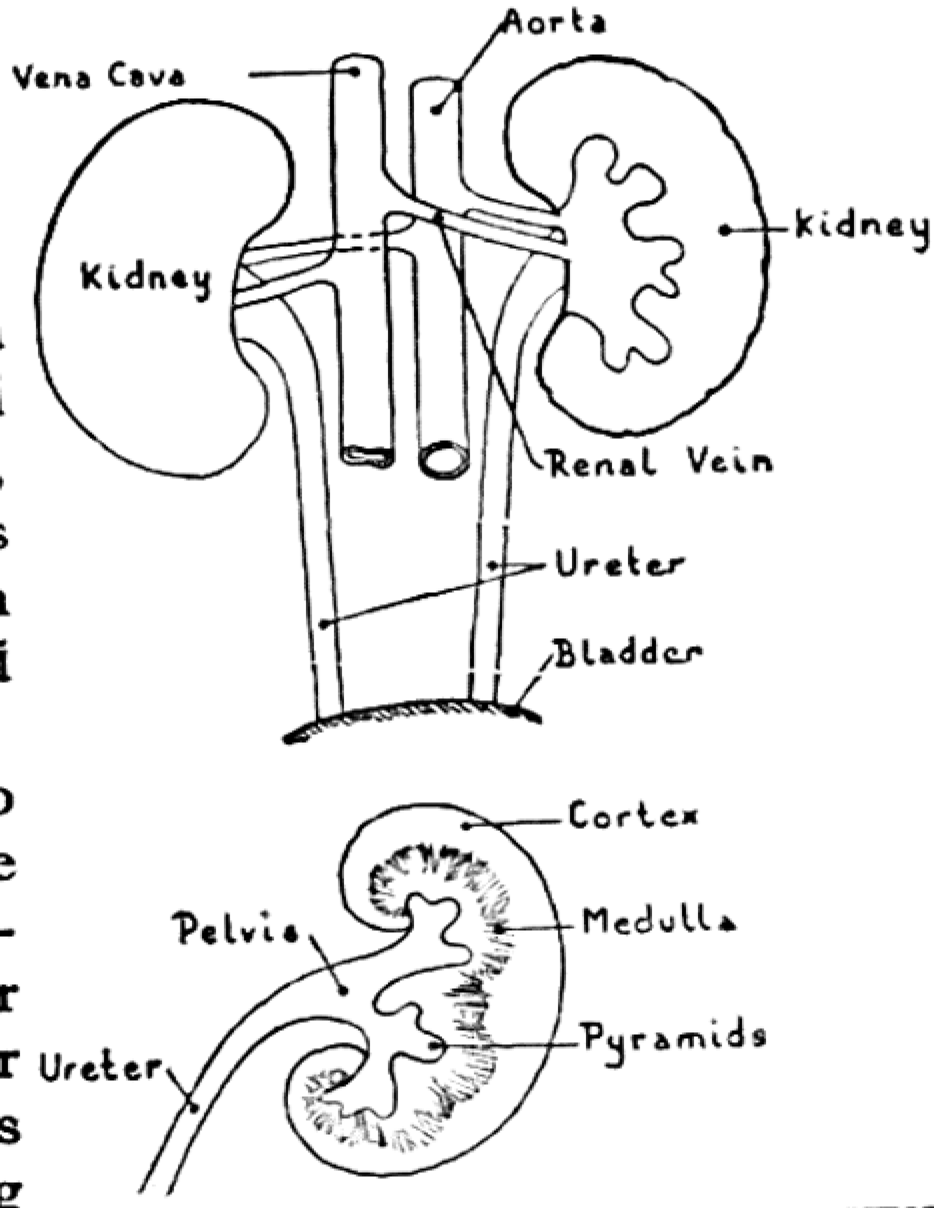


Fig. 27. THE KIDNEYS AND THEIR STRUCTURE

The skin contains myriads of tiny hairs, the base of each being enclosed in a follicle or sheath; it also contains glands of two kinds: (*a*) sebaceous glands, (*b*) sweat glands. The small sebaceous glands are usually connected with hairs and open into the hair follicles; they secrete an oily fluid which passes upwards along the hair, giving it a greasy coating, and some of the oil is deposited on the skin. The primary purpose of this 'natural

oil' is probably to protect the body, particularly the head, where the hair is far thicker and longer than elsewhere, from moisture and from the elements. It also nourishes the root

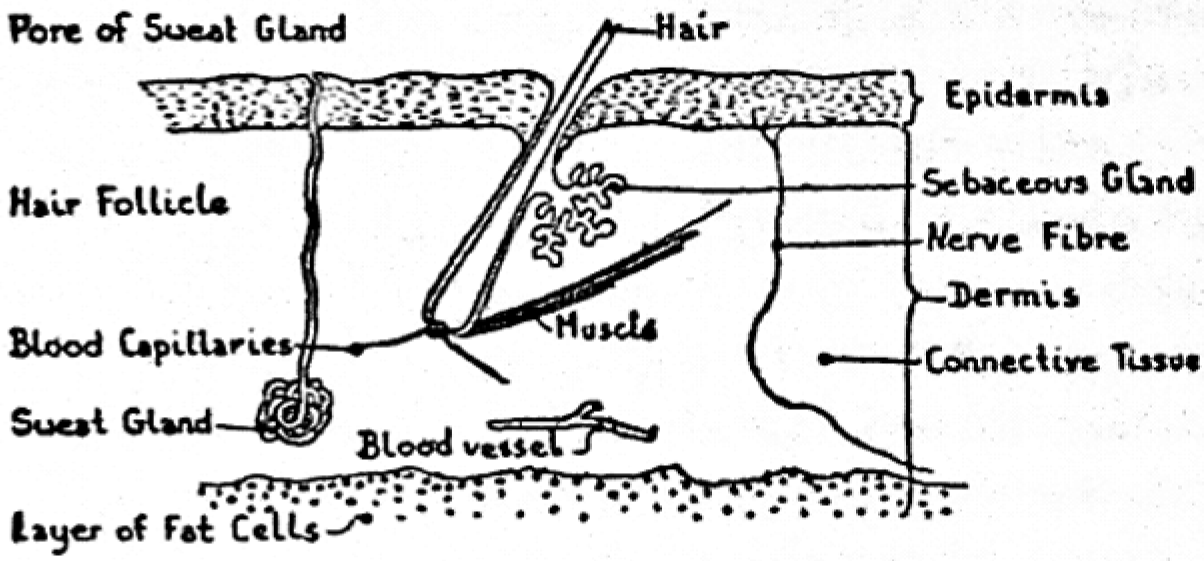


Fig. 28. THE STRUCTURE OF THE SKIN

of the hair and lubricates the skin, making it supple. (See Fig. 28.)

It is the sweat glands that carry out the excretory function of the skin and the closely allied temperature control. They are minute coiled tubular glands with tiny ducts opening on the surface of the skin as pores. Round the coiled portion blood capillaries form a mesh-work, the fine membrane of the blood vessel coming in close contact with the membranes of the gland tubes. When the body becomes hot through exertion or through contact with warm air the blood vessels are dilated, and water from them together with traces of all the other excretory products passes through into the gland as sweat, and is carried to the surface of the skin, where it may be seen as small drops. The excretion of sweat is carried on continually whether it becomes visible or not, but when the sweat is visible considerable evaporation takes place from the warm surface of the skin and the body is rapidly cooled down. Sweat contains various waste substances, including salt, urea, traces of sulphur and a very small quantity of carbon dioxide.

Although elimination from the alimentary canal is not, strictly speaking, 'excretion', it may conveniently be considered here.

In the alimentary canal the chyme that passes into the small intestine is converted into a milky fluid called chyle (for use) and a thick residue (for excretion).

The small intestine enters the large through a narrow aperture guarded by a valve which ensures one-way traffic only. The large intestine is much wider, but shorter than the small, and lies outside it in a kind of frame. It runs upwards to the liver, then crosses to the left and leads down into the rectum or lower bowel which terminates in the anus.

The waste food substances, frequently of a fibrous and insoluble nature containing waste cells and dead bacteria are passed from the small into the large intestine. A large amount of water is absorbed by the wall of the large intestine, the waste matter becomes more solid, until it is ejected into the rectum and through the anus.

Remaining Systems of the Body

The skeletal, osseous or bony system of the body forms its supporting framework. The covering or integumentary system, consisting of skin, hair and nails, protects the body and holds it together. The muscular system gives it its power of movement. The reproductive system, consisting of the generative organs, provides for the creation of new life. Secreting glands separate out, produce and store the special substances needed, and form the secretory system; while the lymphatic 'glands' and vessels comprise the lymphatic system, acting mainly as a 'shuttle service' between blood and tissues.

In control of all the other systems, co-ordinating and regulating them, is the nervous system, consisting of brain, spinal cord, and the nerves. The nerves carry impulses or messages from the sense organs to the brain and spinal cord, which return them to organs which bring about a response. The nervous system deals with both the unconscious functioning of the body and our conscious movements, our feeling and thinking, remembering and reasoning.

22

Personal Hygiene

It is of great importance to take all the normal measures for the care of our bodies.

Health. All parts of the body are stimulated and benefit by exercise (which quickens the beat of the heart temporarily and increases the supply of oxygen to the blood and the rate of excretion by the skin); and by plenty of sunshine and fresh air.

Sleep and rest are the periods for repair and growth; adequate and regular sleep are therefore of great importance. Sleep is sounder and deeper if preceded by relaxation and by a light snack, but *not* a heavy meal. The heart beats more slowly when the body is at rest; and since the blood is therefore being oxygenated less quickly it is particularly important that an open window should ventilate the bedroom and keep the oxygen content of the air in it high.

For the fuelling of the body enough food of the right kind is needed; and to avoid accumulation of decomposing waste matter regular elimination is important.

A vital factor in keeping fit and avoiding illness is, of course, cleanliness.

The Care of the Skin. A dirty and unhealthy condition can quickly arise unless the skin is constantly cleansed. If, however, the natural oil is removed from the skin by the continual use of water and strong alkalis, such as soda or harsh soap which emulsifies the oil, the harmful effect is seen in chapped hands and roughened and reddened skin. But oil has an attraction for dirt and dust which will, therefore, adhere to the skin, and require continual removing. In addition, the waste materials from the sweat collect as the sweat evaporates, and mixed with

these are the dead cells which are constantly being shed from the epidermis. The pores tend to become clogged and unsightly blackheads are formed, while bacteria enter the pores and the hair follicles, producing small gatherings or pimples. It should be noted that these bacteria are, as a rule, infectious only to the person concerned and that they are not *necessarily* caused by neglect though they obviously flourish best in dirty conditions.

The whole surface of the body should be cleansed frequently. A daily bath is desirable, or a brisk rub down with a rough towel may be substituted. Special attention should be given daily to washing the hands, feet and arm-pits where the sweat glands are most numerous. A hot bath, temperature, 105–110° F., should be taken at least once a week. Soap is necessary to remove dirt and grease, but this should preferably be of the super-fatted type; very strong soaps should be avoided. Cosmetics, if heavily applied, can have a harmful effect and clog the pores. They should be adequately removed, and the skin should be carefully cleansed after their use. The mechanism for the regulation of temperature by means of the skin, which like so many bodily processes is a matter of delicate adjustment between the nervous system and the circulation, can be interfered with if the body is covered by a layer of dirt, or by grease paint.

The Care of the Hair. The hair, being greasy, easily collects dirt and soot from the atmosphere; the loose cells on the surface of the scalp collect round the base of the hairs and are not readily removed; the sweat glands are active on the scalp; and, lastly, scurf or dandruff tends to form among the hairs. For these reasons and because hairs soon mat together the hair needs very thorough brushing and combing at least twice a day. At intervals of from seven to fourteen days it should be well washed with warm water and shampoo, preferably of the soapless variety which will not destroy the valuable natural oils. Drying in the fresh air and sunshine are beneficial.

There is always a certain risk—more particularly if the hair is worn long—of being infected with the head louse from somebody else's head. Therefore it is never desirable to wear someone else's hat or to rest the head on railway carriage cushions. The lice lay their eggs or nits on the strands of the hair where it is thickest, at the back or behind the ears. The eggs are attached by a kind of cement, and since they are therefore difficult to remove treatment must continue after lice have been killed, so that any further lice that may hatch out are destroyed too. Preparations are obtainable from chemists which will remove the lice and nits if instructions are carefully followed.

Care of the Nails. The nails spring from the epidermis and are made up of flattened, horny cells. As the under portion of the top of the nail collects dirt it is necessary to keep nails short and to brush them frequently, cleaning them afterwards, preferably with an orange stick which will not scrape the enamel. They should be evenly filed into a suitable shape, and the cuticle at the bottom of the nail gently forced back to show the half-moon portion. To break the skin round the nails is painful and leads to an untidy and ragged effect. Nail-biting, which is usually a sign of nervous tension, is a harmful and objectionable habit, deplorable from an æsthetic point of view.

Care of the Teeth. The enamel of the teeth is a very hard substance which gives them their white and smooth exterior; it is, however, brittle, and can easily be chipped or broken. It is at the junction of the tooth with the gum, where, it will be remembered, the enamel ceases, that the germs of decay most readily attack the tooth, eating into the dentine and gradually destroying it. When the decay thus formed reaches the pulp cavity the nerve is exposed and toothache ensues. Poisons are produced by the germs and are carried by the blood to the heart, and thence to other parts of the body. Such ill effects as septic tonsils, rheumatism and stomach and heart trouble can be produced by the poisons from decaying teeth.

The care of the teeth is obviously of the utmost importance in maintaining good health. They should be cleaned first thing in the morning, if possible after each meal, and, most important of all, before going to bed. Acid fermentation in the mouth, caused by food lying between the teeth, encourages the development of dental bacteria; a stiff tooth-brush worked vertically up and down the teeth and gums will remove the food traces, and an alkaline tooth paste will neutralise the acid. After the teeth have had their last brushing of the day nothing further should be eaten—especially not sweet and starchy foods such as biscuits—except perhaps a small piece of apple, which will have a cleansing effect, and is therefore a good thing to take after any meal.

The foundations of good teeth are laid before an infant is born, and a proper diet for both the mother and child are of great importance. Infants and young children need enough milk containing calcium and foods containing Vitamin D, such as cod-liver oil.

Both children and adults should visit the dentist regularly for inspection and treatment; if cavities are filled when the first signs of decay appear the treatment is painless and the teeth may be preserved indefinitely.

Personal Parasites. Mankind can be attacked by both external or internal parasites. The former are within our power to avoid by cleanly habits and by instant treatment, if infected. The latter are frequently brought into our systems by infected foods of which we are not aware. Meat is inspected and passed as fit for human consumption before it is sold in shops but it should not be eaten raw and pork, in particular, should not be eaten underdone. Dogs should not be allowed to eat from the same plates as human beings, and everyone dealing with food should be induced to observe scrupulous cleanliness in its handling.

The most common internal parasites are worms, particularly the tape-worm. External parasites include the *flea* and the

louse. The latter we have dealt with under the care of the hair. The *flea* feeds on the blood of men and animals and, in mankind, is harboured in clothing, particularly woollens and blankets, and bedding. Its bite injects a mild poison under the skin, which gives rise to irritation. It can be discouraged by cleanliness and the use of D.D.T. The use of the vacuum-cleaner in public vehicles, cinemas, etc., is said to have decreased the number of fleas considerably.

The simple rules of personal hygiene can be understood and practised by everyone and as far as possible made so much a matter of habit that a healthy mode of life becomes natural and automatic.

The laws of health whether applied to the person or the home are the weapons by which the good citizen is enabled to fight disease with its accompanying miseries. Much has been accomplished in the last few years by legislation and education; with the help of an enlightened community there are even greater possibilities for the future.